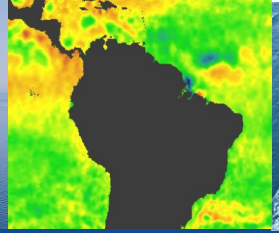
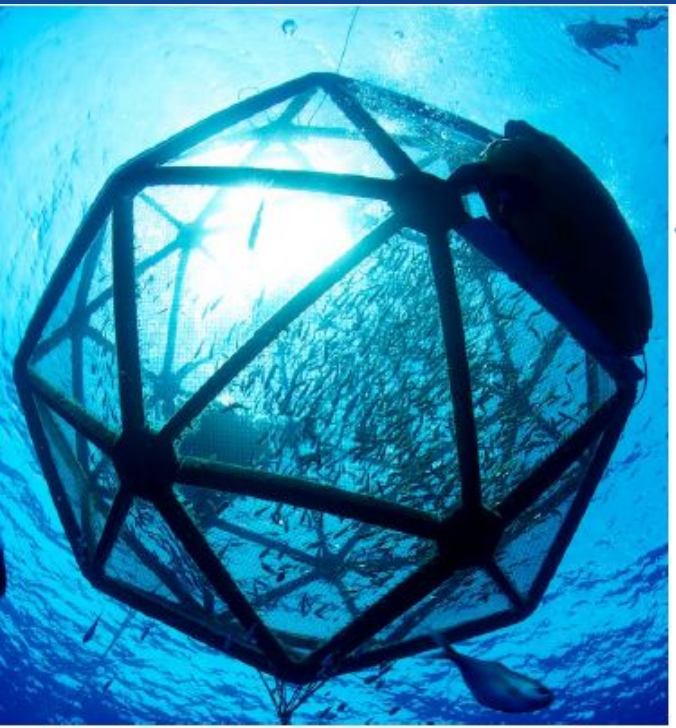
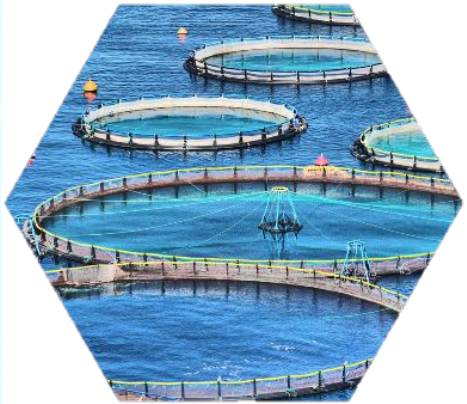




Blue Water Fisheries Revised Site Analysis


NCCOS | NATIONAL CENTERS FOR COASTAL OCEAN SCIENCE

NOAA Office for Coastal Management
NOAA National Centers for Coastal and Ocean Science
James.Morris@noaa.gov

Background / Farm Requirements

- Fall 2019 - Initial meetings with NCCOS and BWF
- Nov 2019 - Oct 2020 - Spatial Analysis and iterations completed
- Nov 2020 - Final Report Pre-Applications meetings
- Jan-Mar 2023 - Updated spatial analysis

CASS Request Farm Response (2019/2020)	
Preferred Ports	Portsmouth, Rye Harbor, Hampton Harbor, Newburyport
Maximum distance from port/shore	≤ 12 nautical miles
Gear depth	≥ 52 and ≤ 90 m
Farm Footprint	265 acres (107 ha)
Seawater temperature	10 to 16 °C at 15-20 m depth
Significant wave height	< 5 m
Farm Orientation Perpendicular to prevailing currents	

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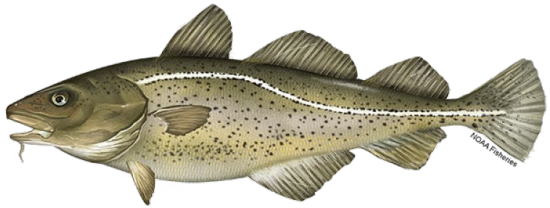
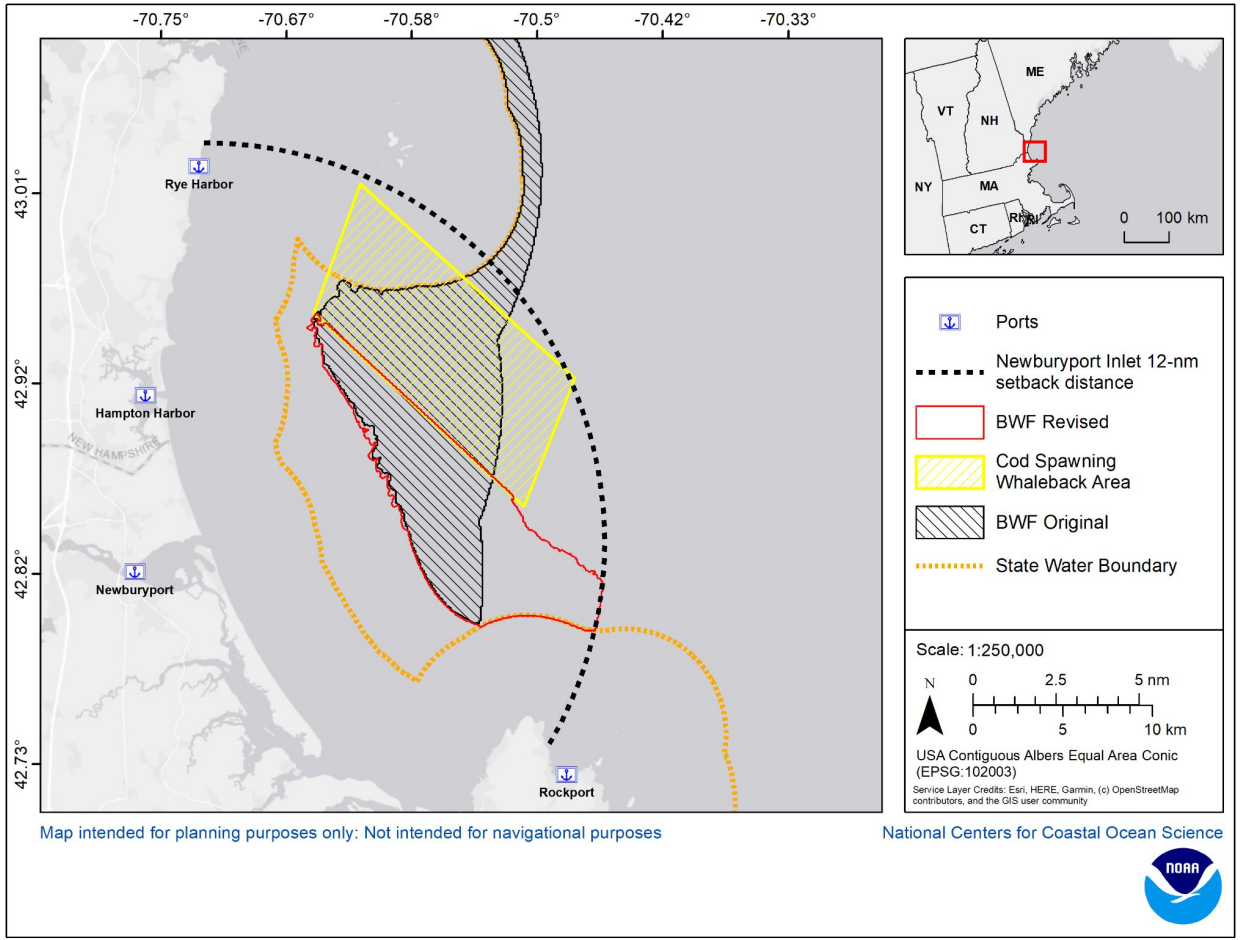
AOI Revisions 2023

Cod Whaleback area now considered a constraint

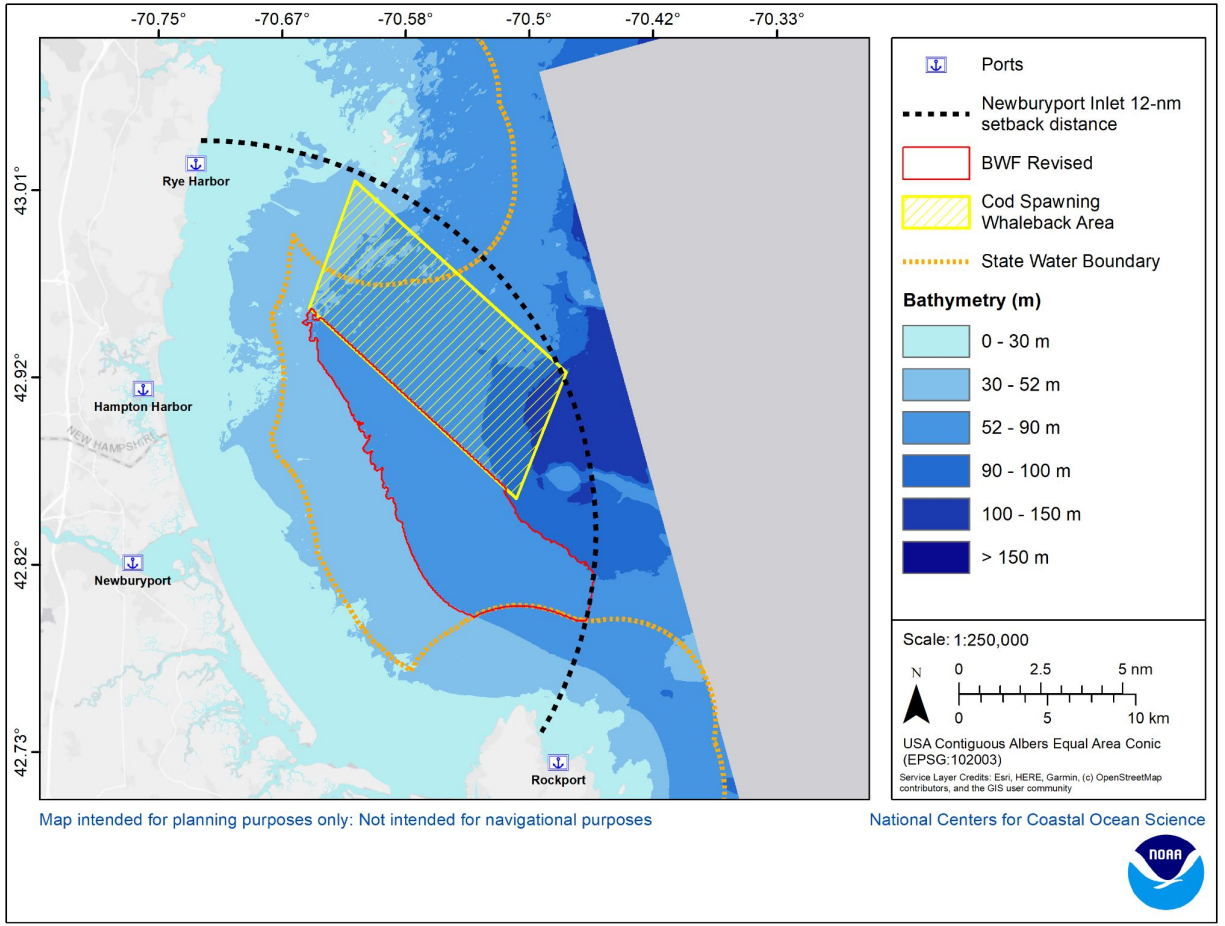
Updated Data Layers and Methods used





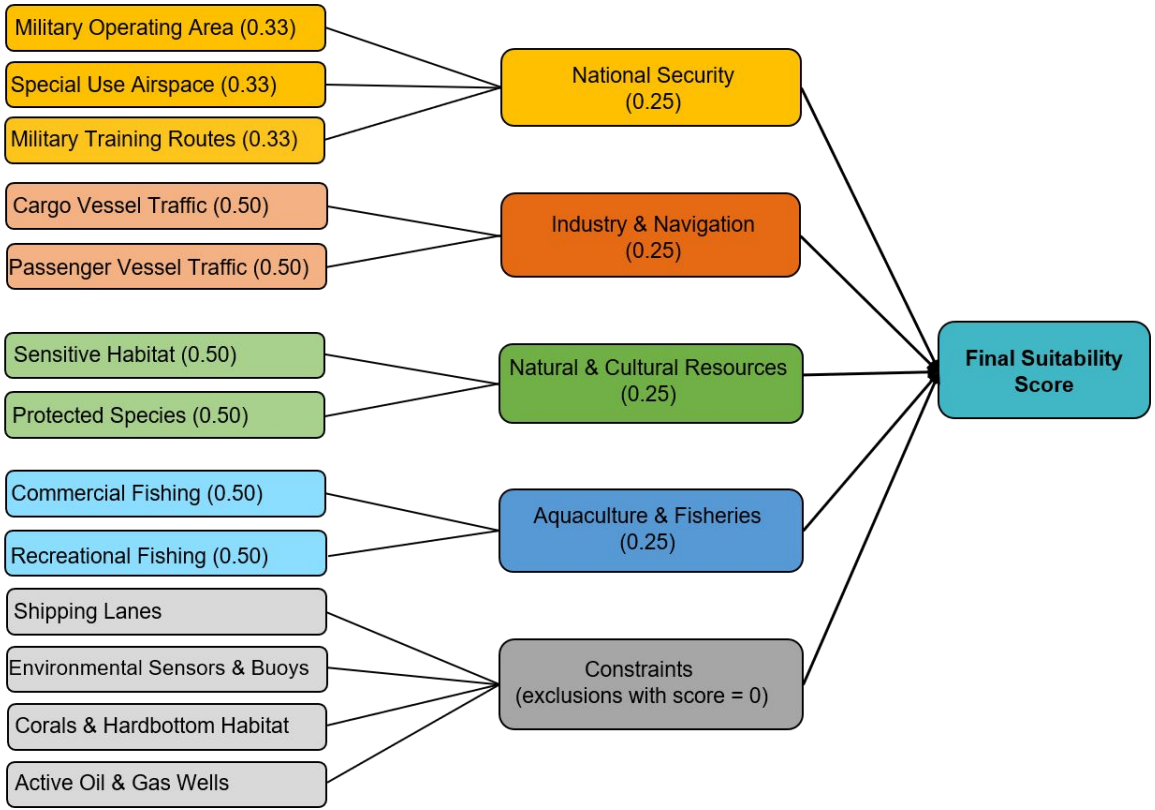
AOI Revisions 2023

Bathymetry 52 - 90 m



Suitability Model Design

- Four submodels and constraints model
- Equal weights for all data and submodels
- Geometric mean used for calculating scores



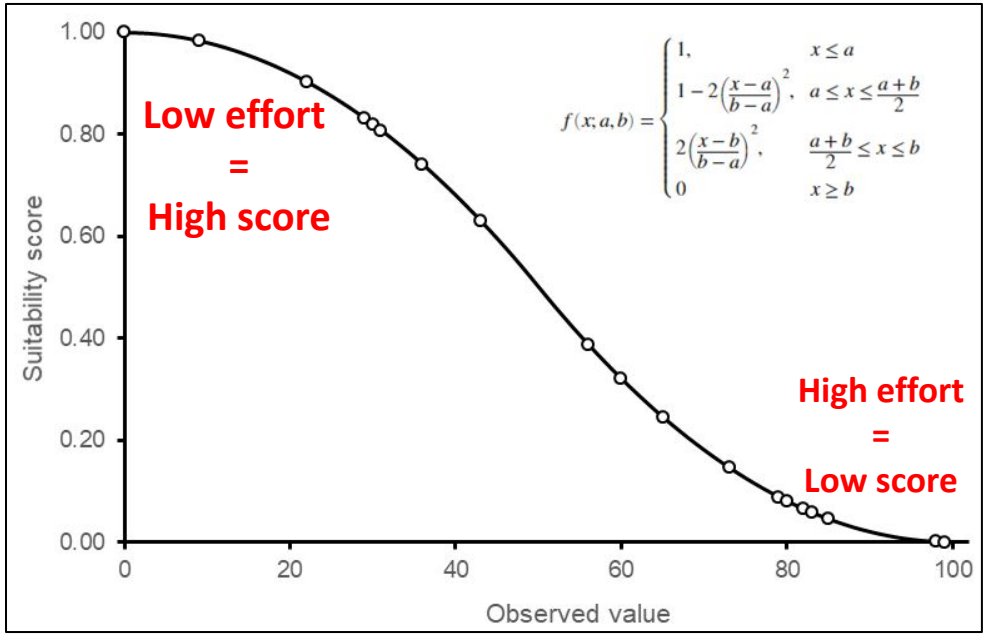
Scoring data to standardized range (0-1)

Categorical data

Layer not compatible = 0
Layer has uncertain compatibility = 0.5
Layer not present = 1

Example Data	Score
Hard Bottom Habitat	0
Military Operating Area	0.5
Oil and Gas Pipelines (500 m setback)	0

Numerical/Continuous data



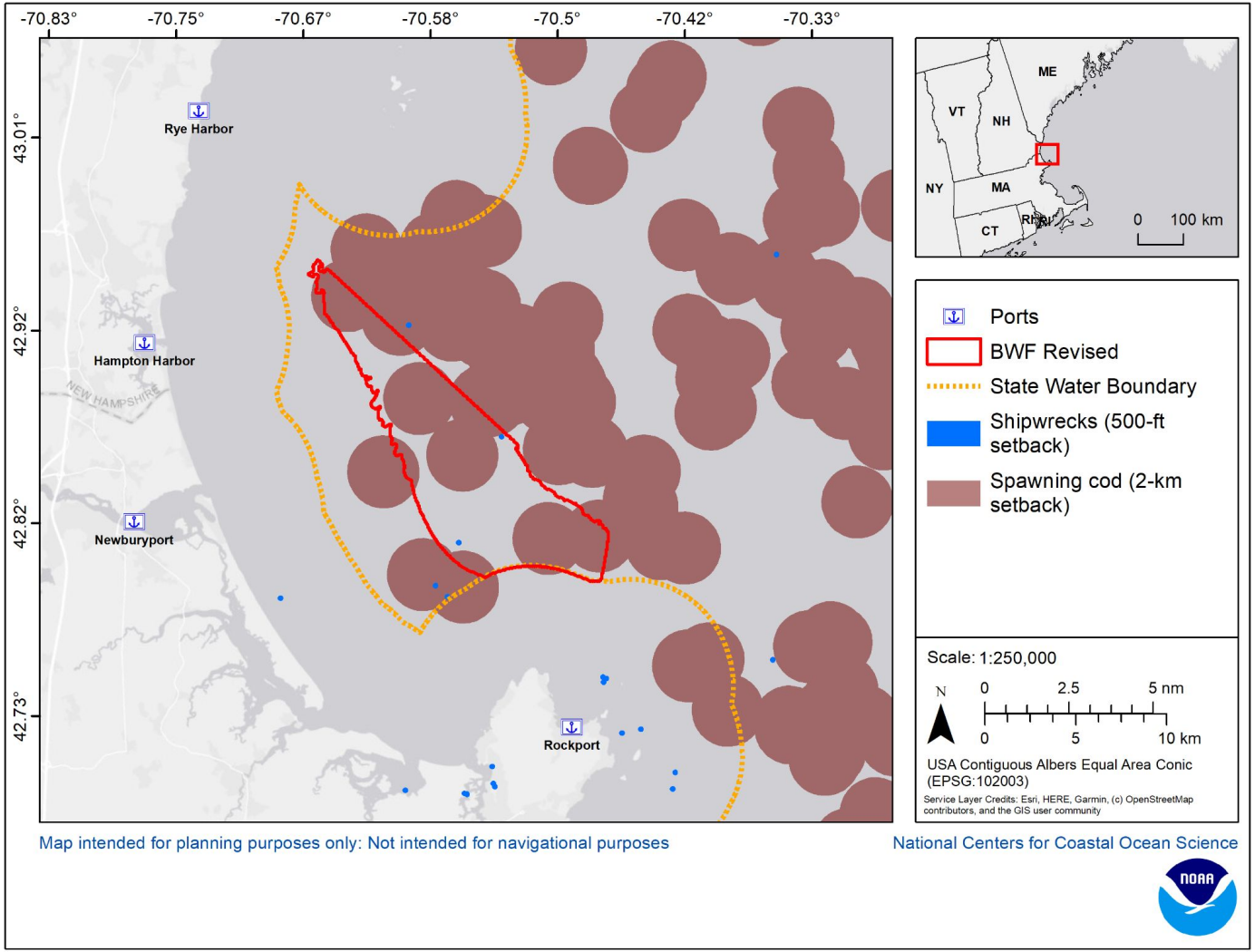
Updated Suitability Model

Submodel	Data Layer	Score
Constraints	Cod Industry Based Surveys 2 km	0
Constraints	ENC Wrecks	0
National Security	Unexploded Ordnance	0.5
National Security	Boston Operating Area	0.5
Industry	AIS SUM 2017-2021	zmf
Fishing	VMS SUM 2009-2019	zmf
Logistics	Sediment grain size (Smaller is preferred)	zmf
Logistics	Distance to inlet (Close is better)	Linear
Logistics	Depth (Shallower is better)	Linear

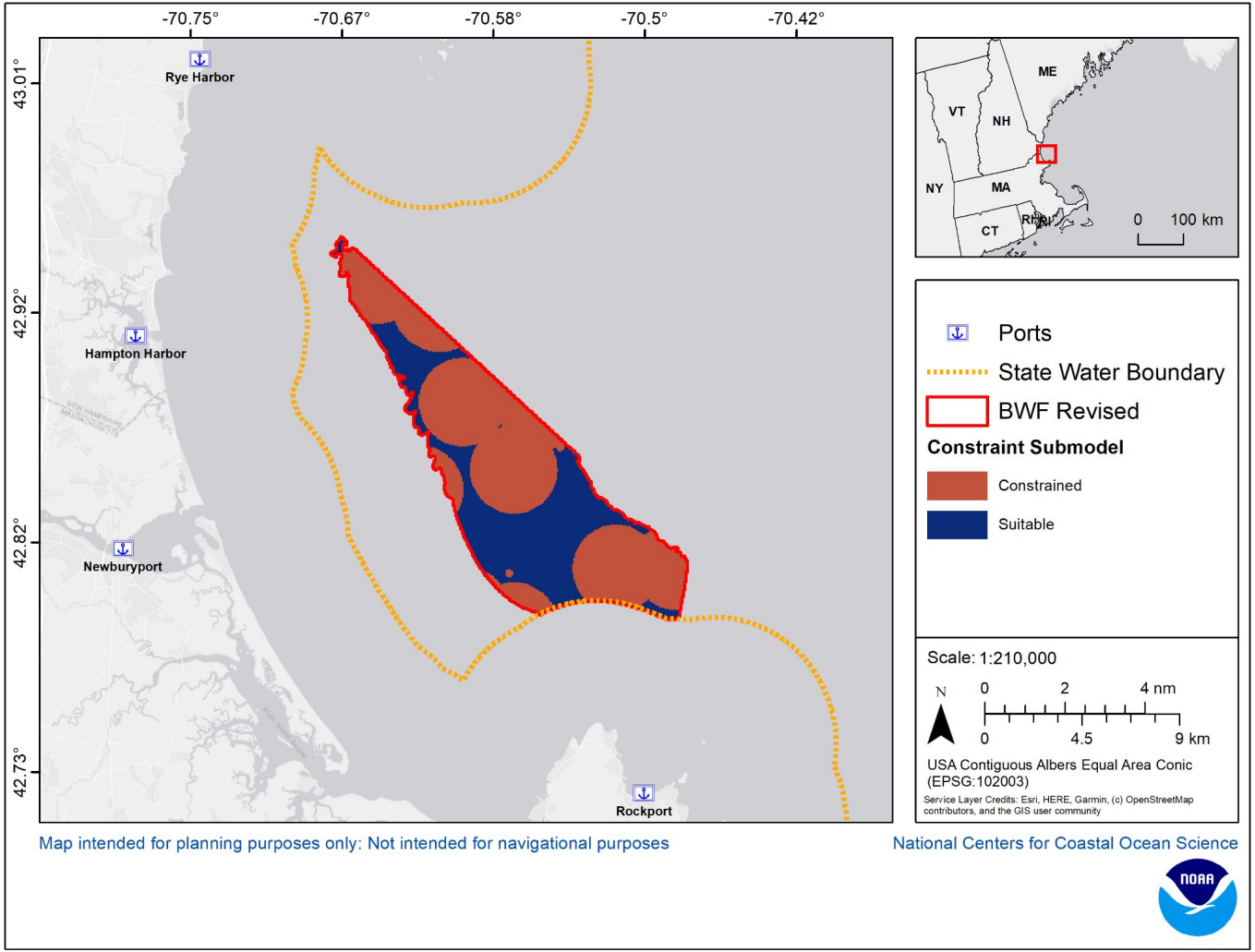
Constraints data Layers

Cod Industry Based Surveys

ENC Shipwrecks



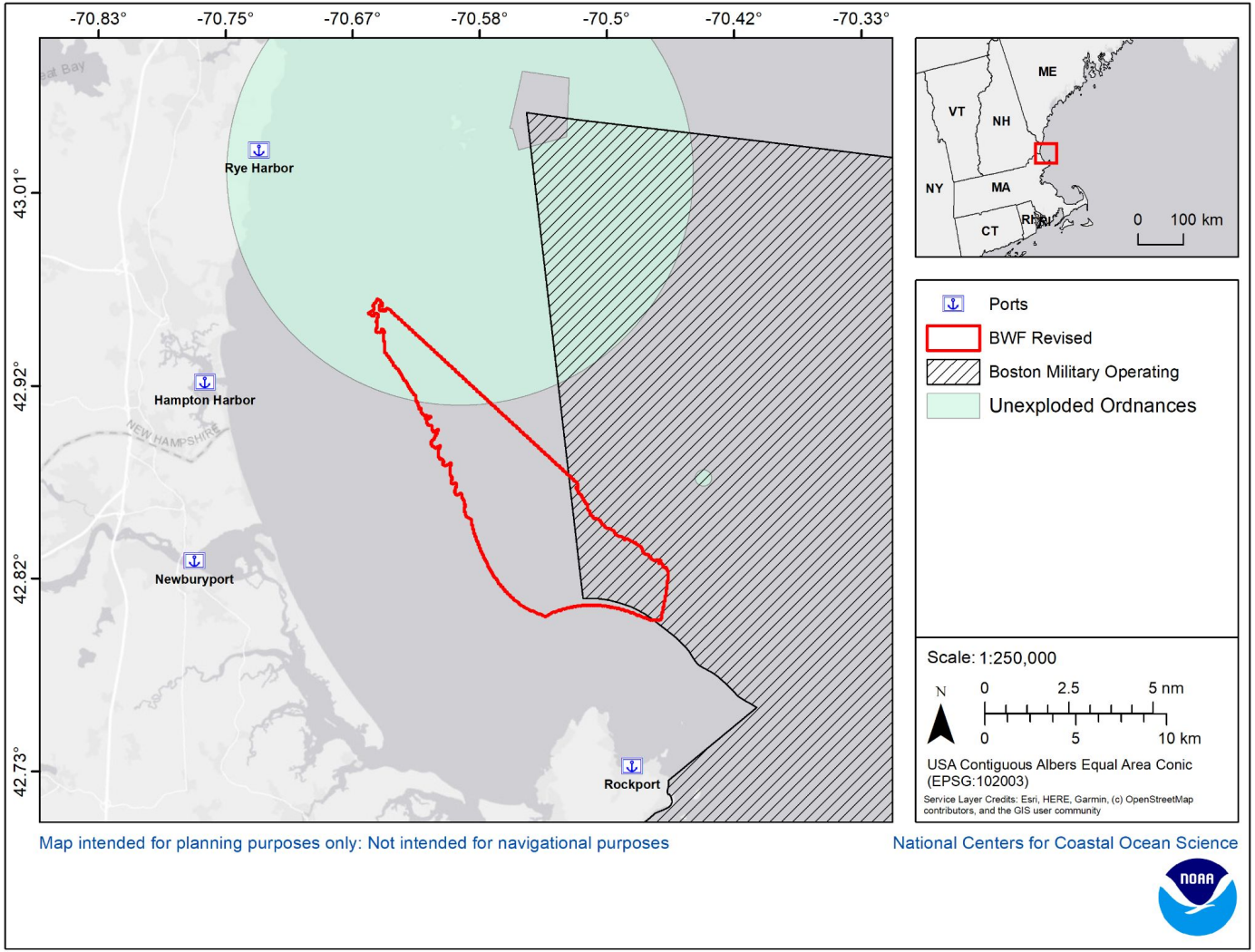
Constraints Submodel



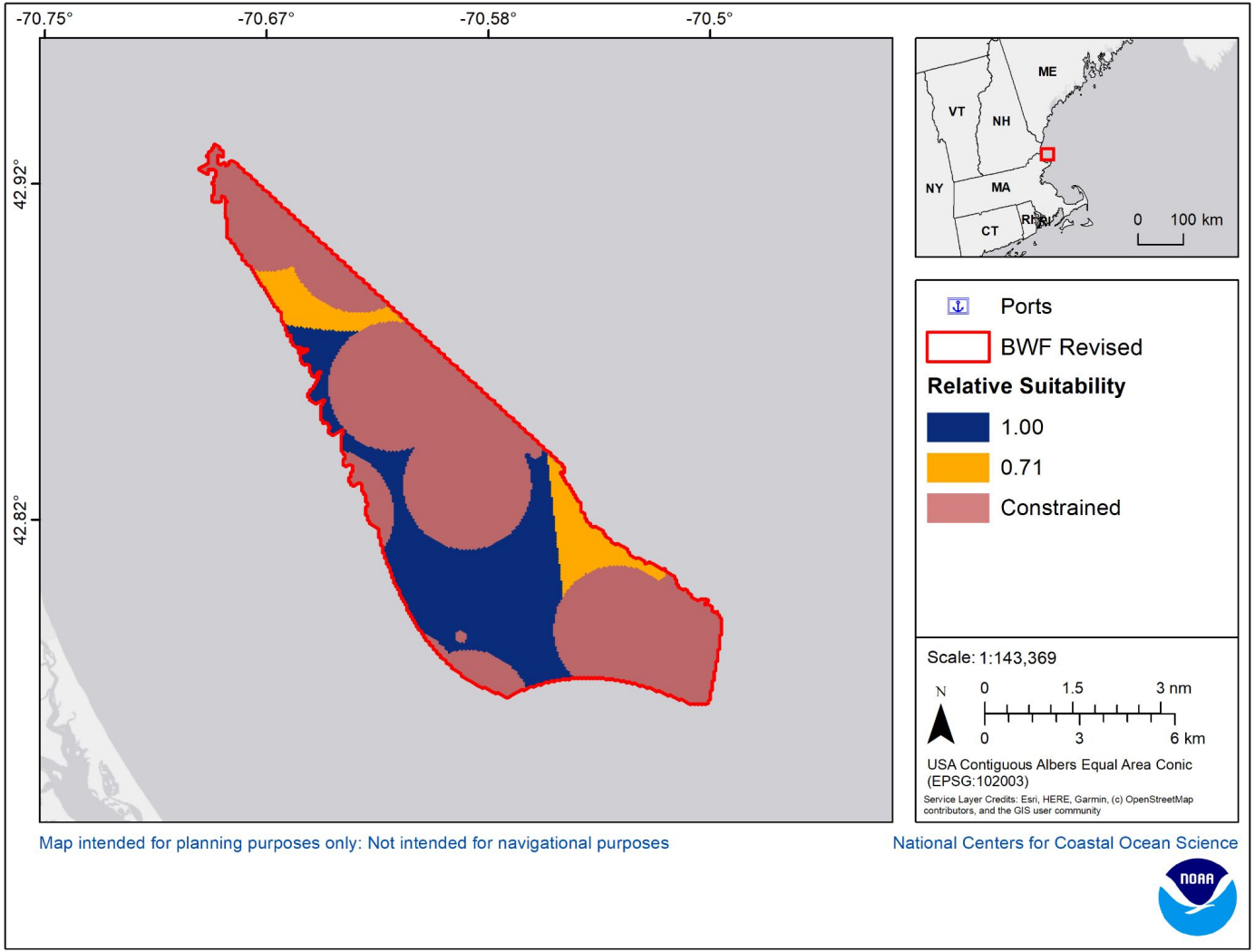
National Security Data

Boston Military Operating Area

Unexploded Ordnances

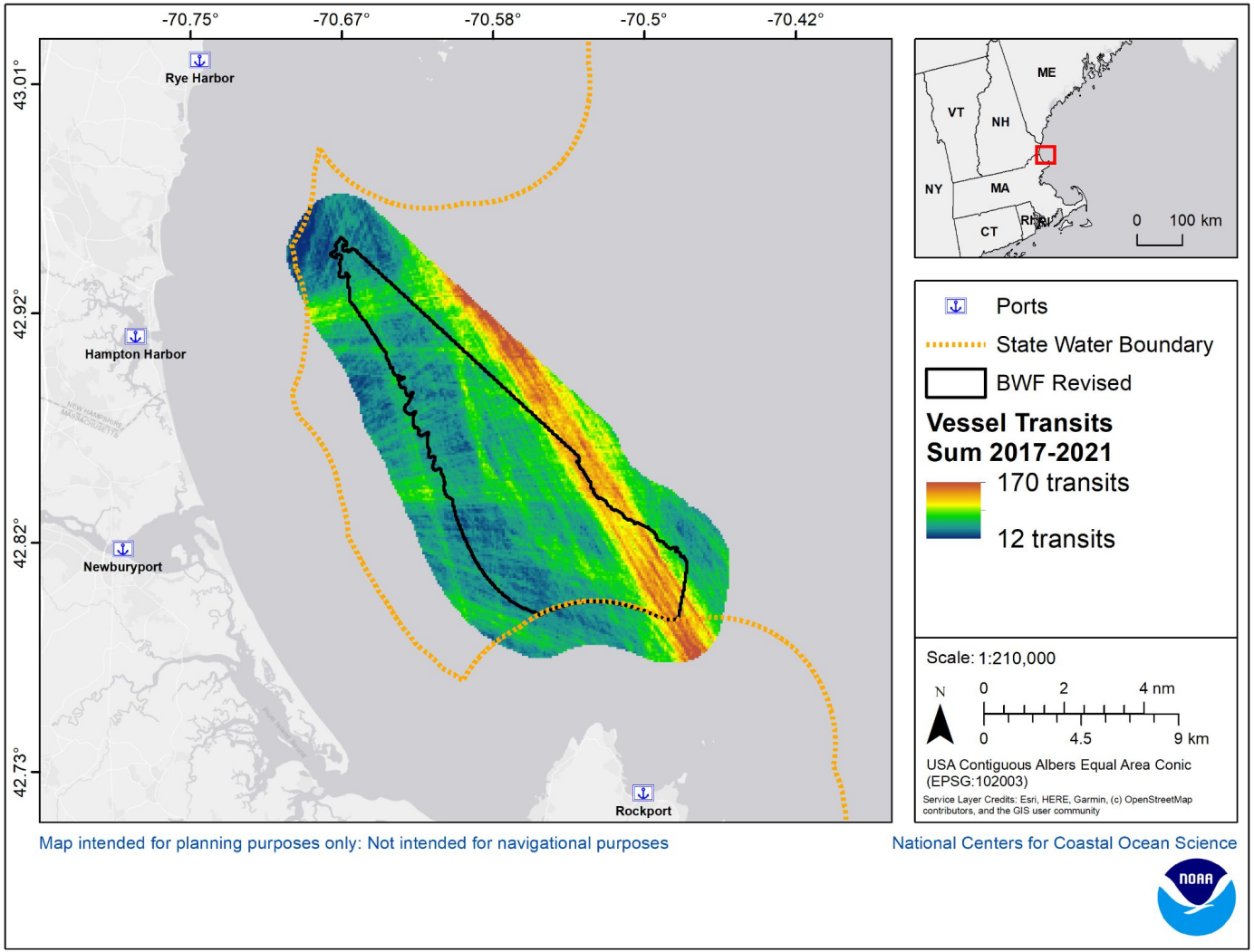


National Security Submodel



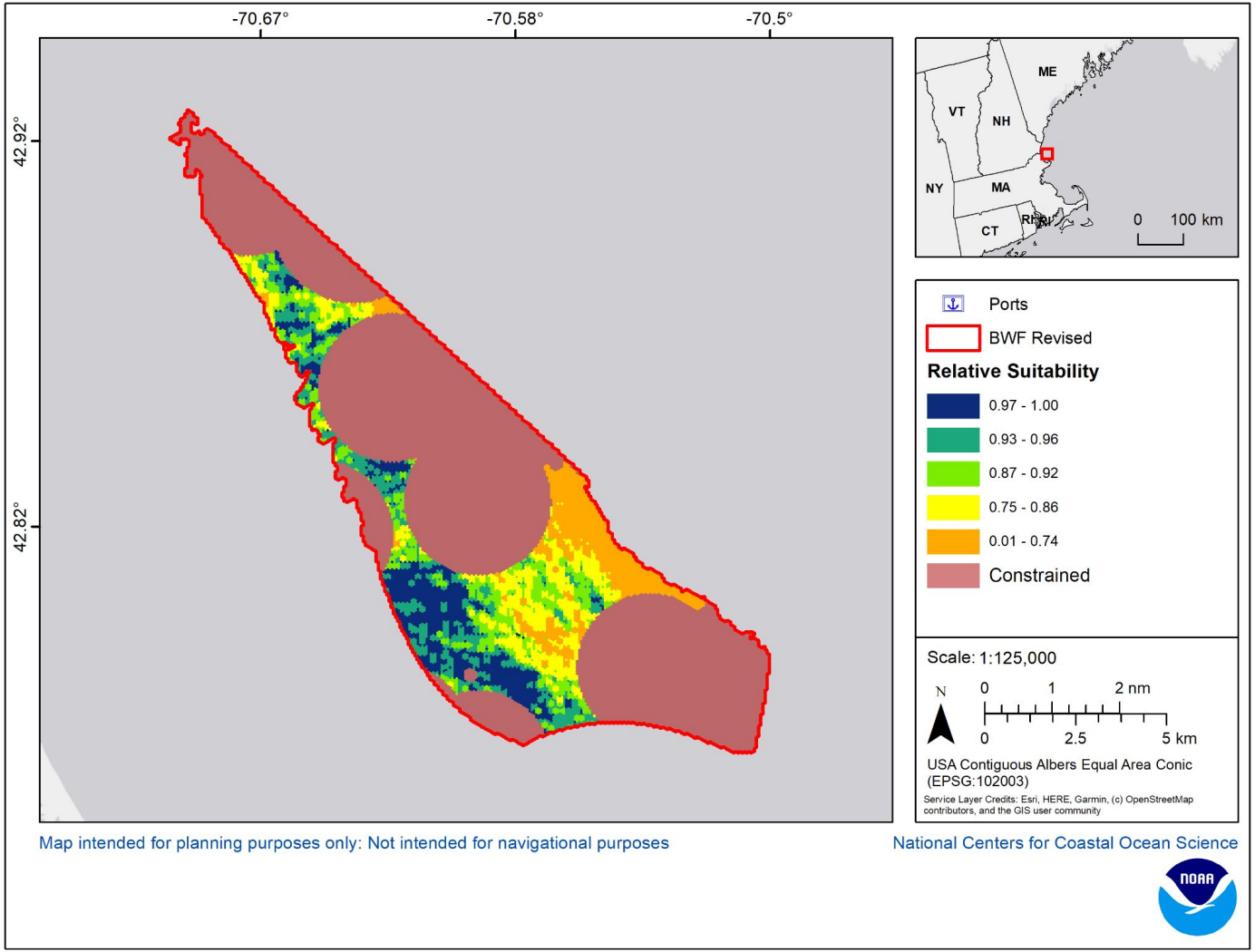
Industry Data

Sum of AIS All Vessel Type Transits 2017-2021



*Note Vessels without AIS transponders not represented (i.e. small fishing vessels)

Industry Submodel



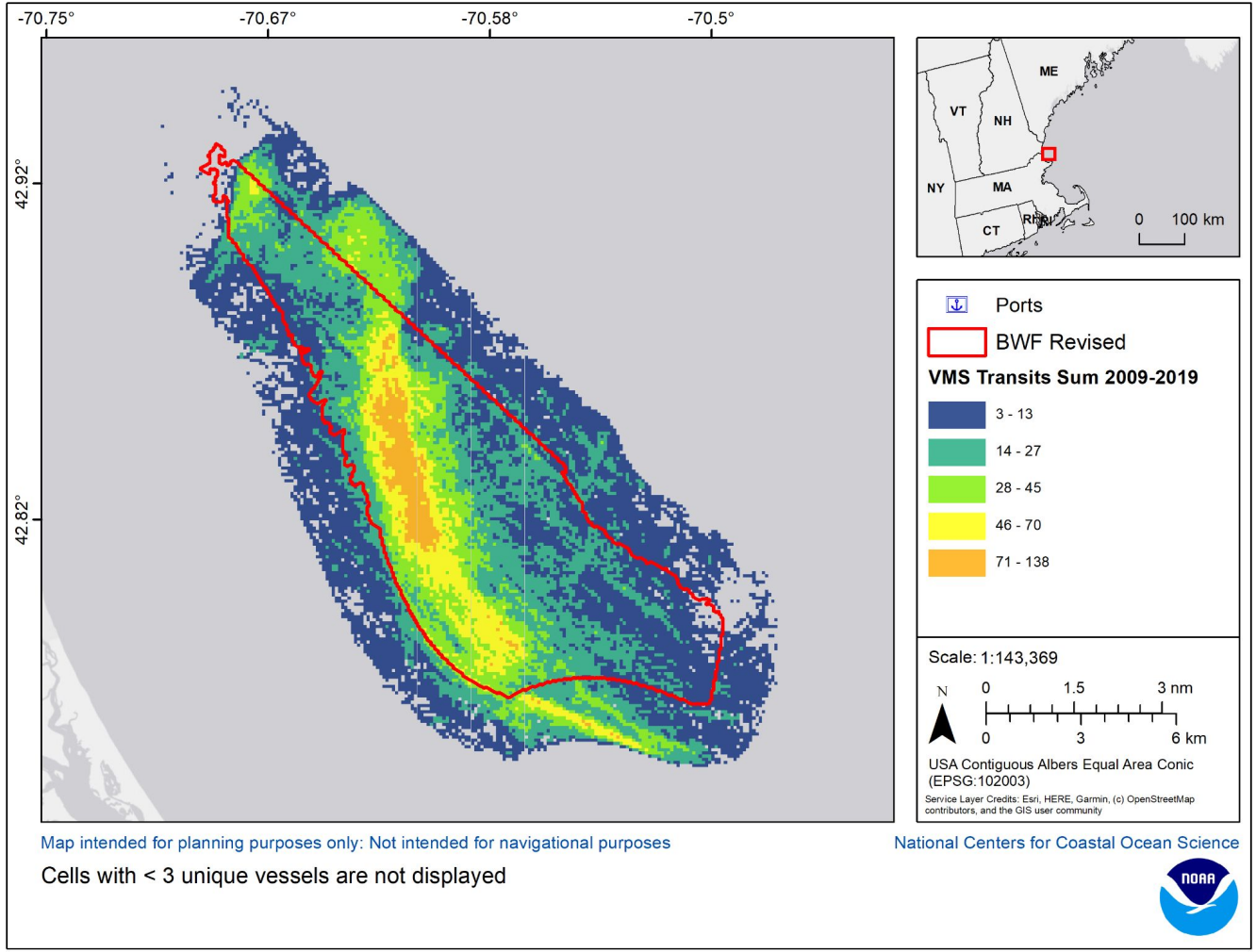
Fisheries Data

VMS (all gear types)

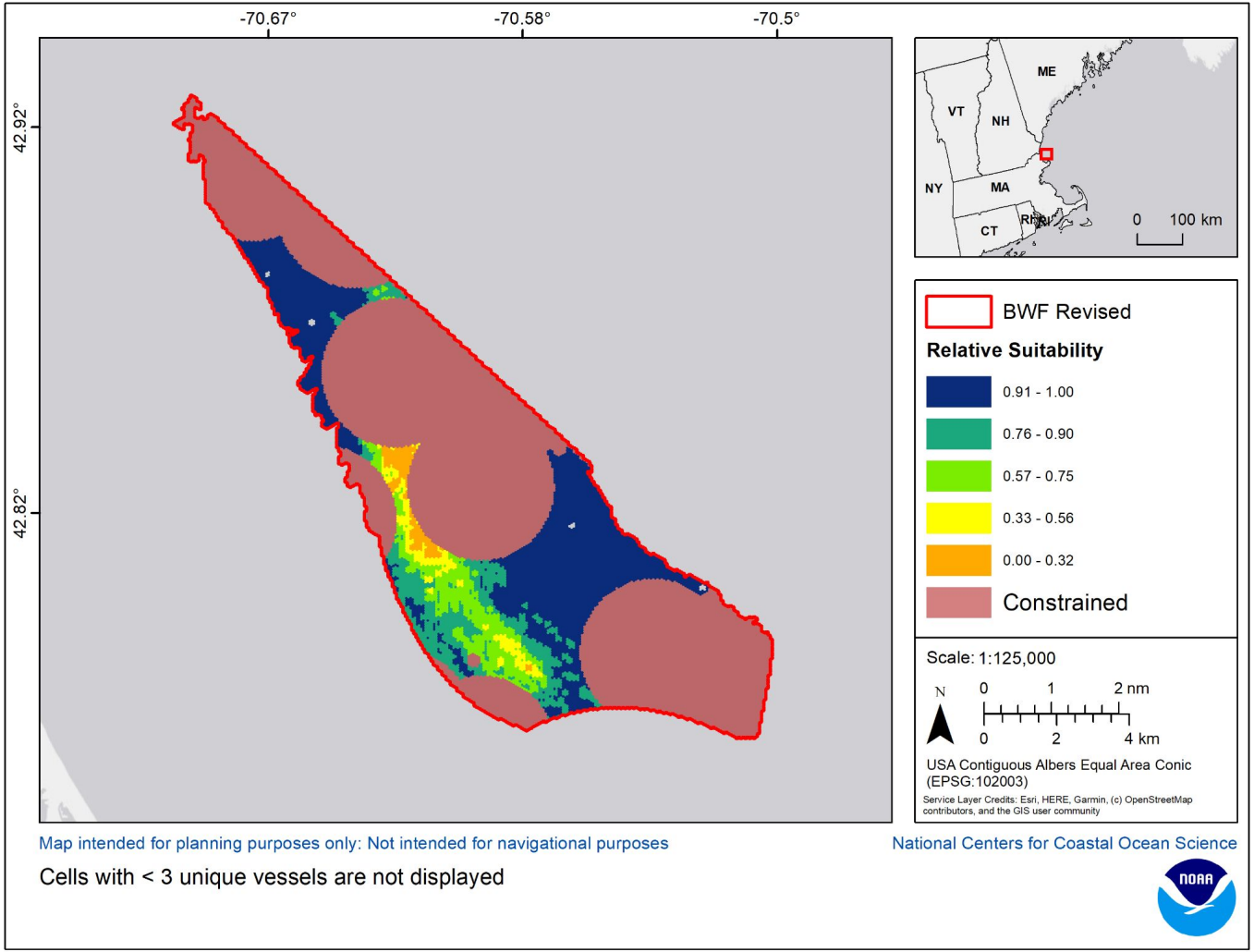
Sum 2009-2019

Tracks created from points that were < 1 mi apart and <1 hr in time difference

All data used in model, but not displayed due to confidentiality



Fisheries Submodel

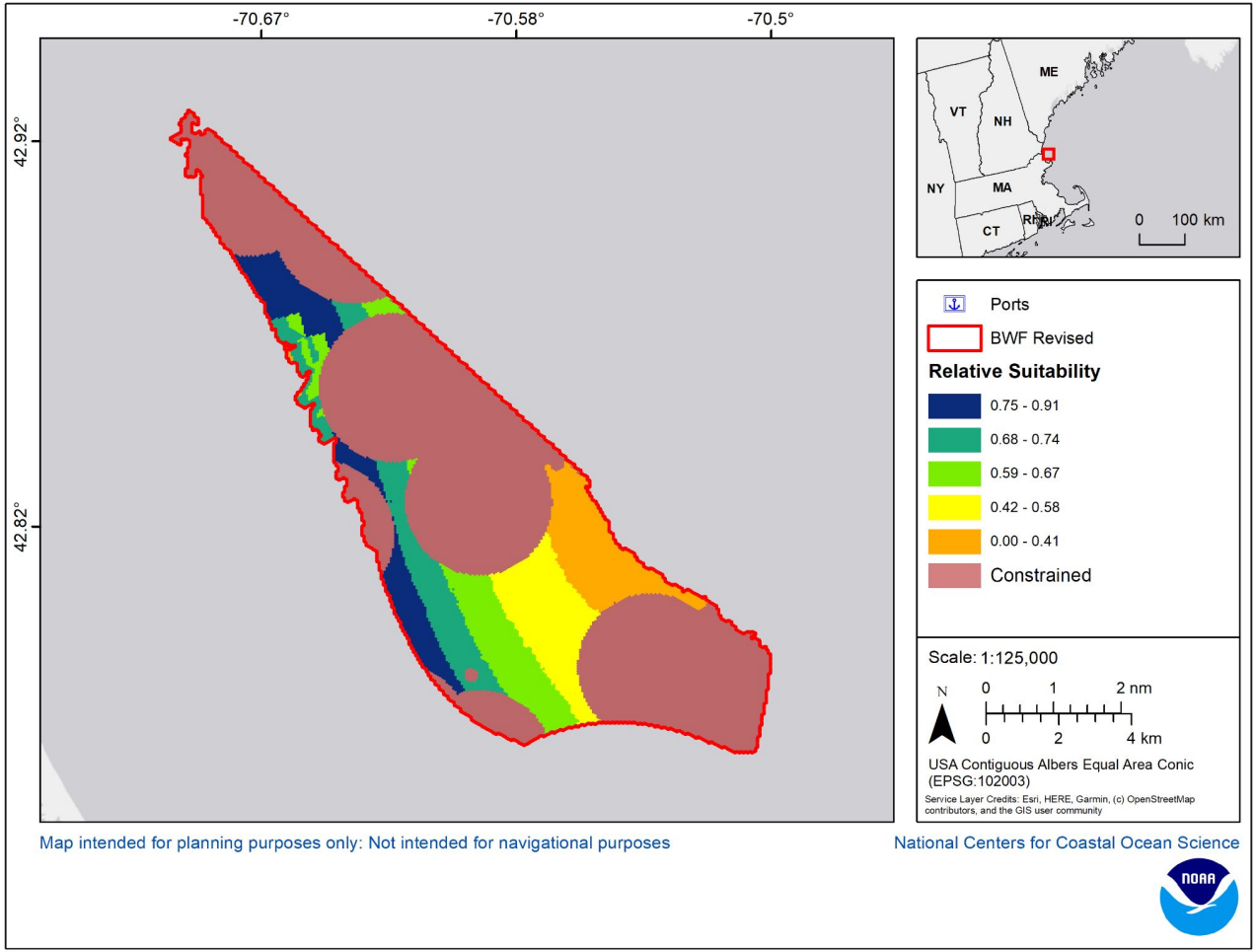


Logistics Submodel

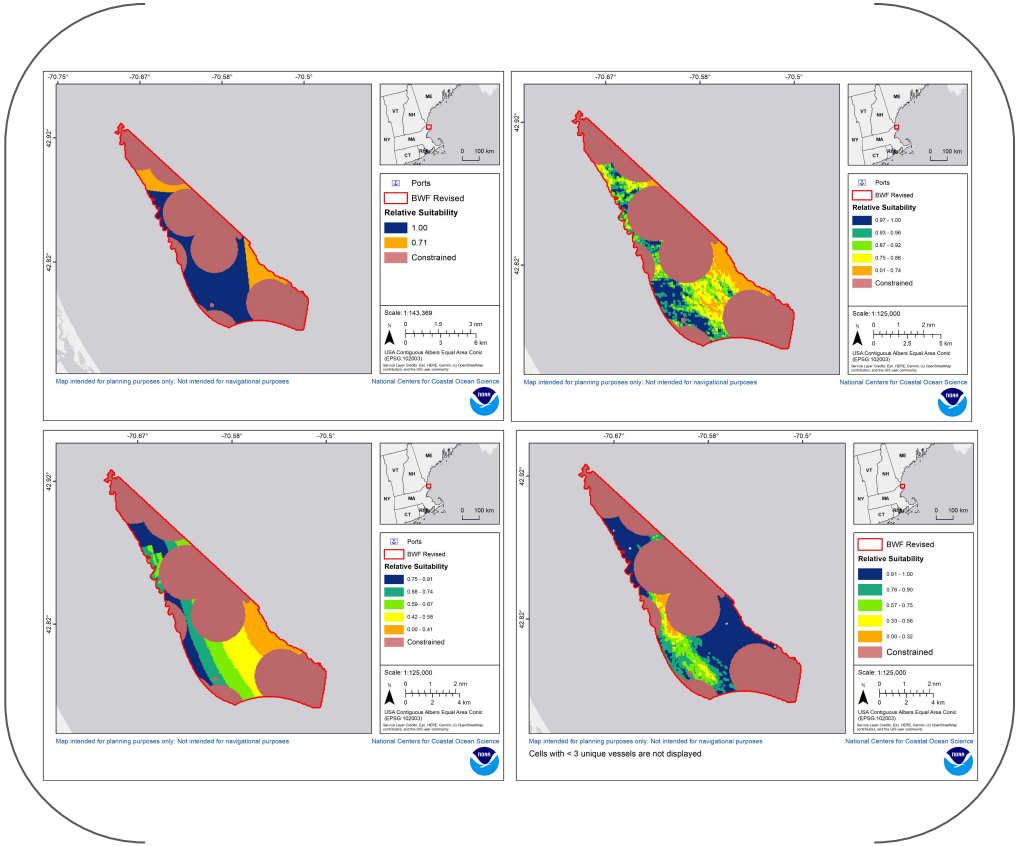
Distance from Inlets

Bathymetry

Sediment grain size



Calculation of Final Suitability Model



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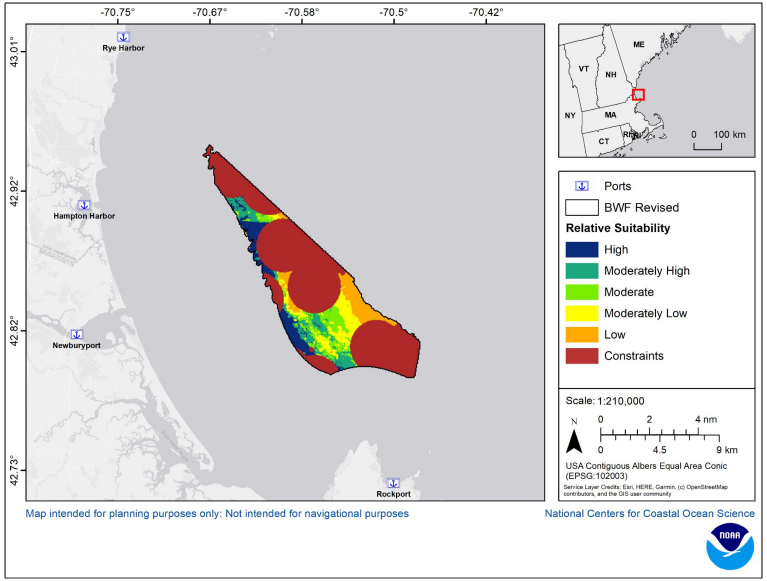
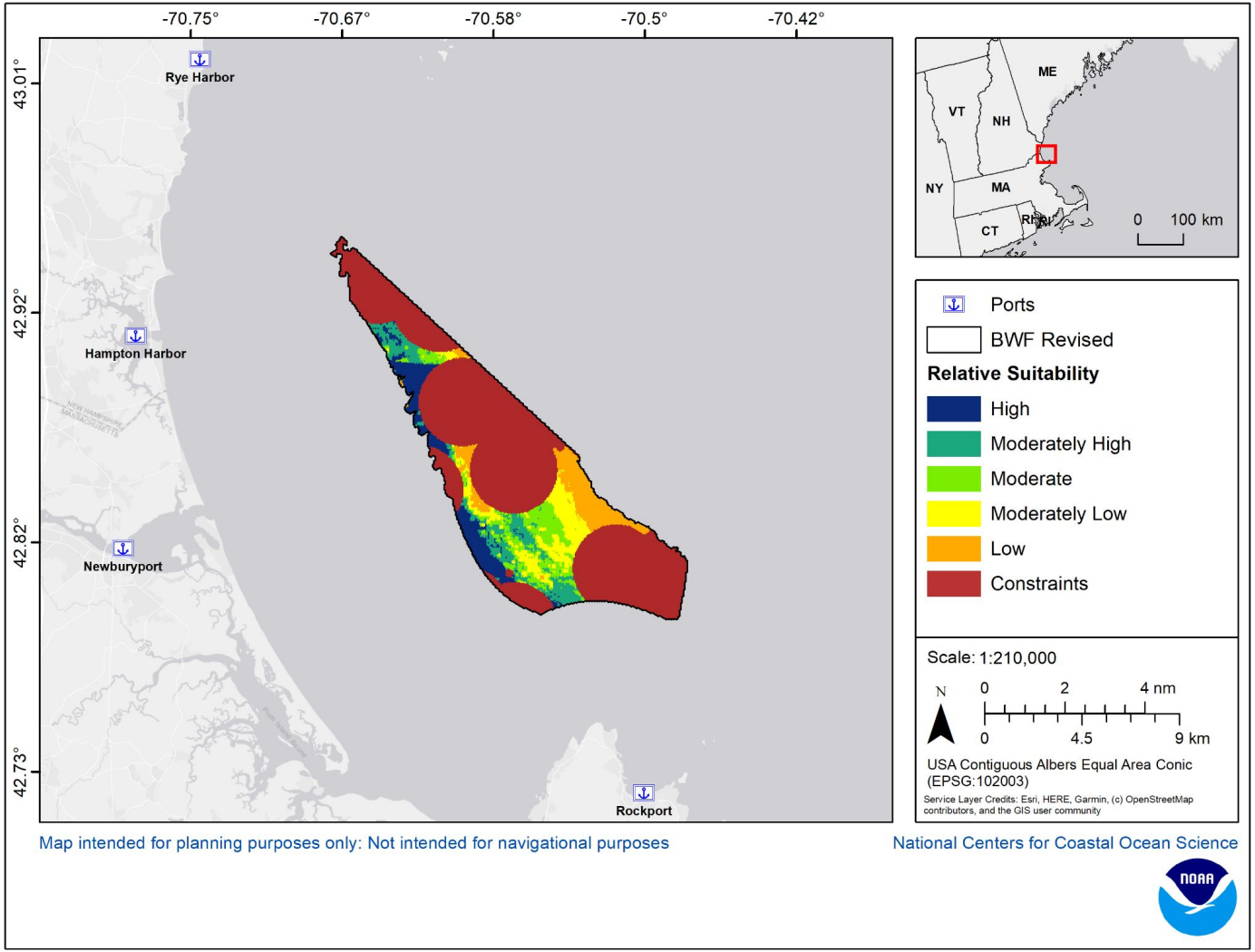


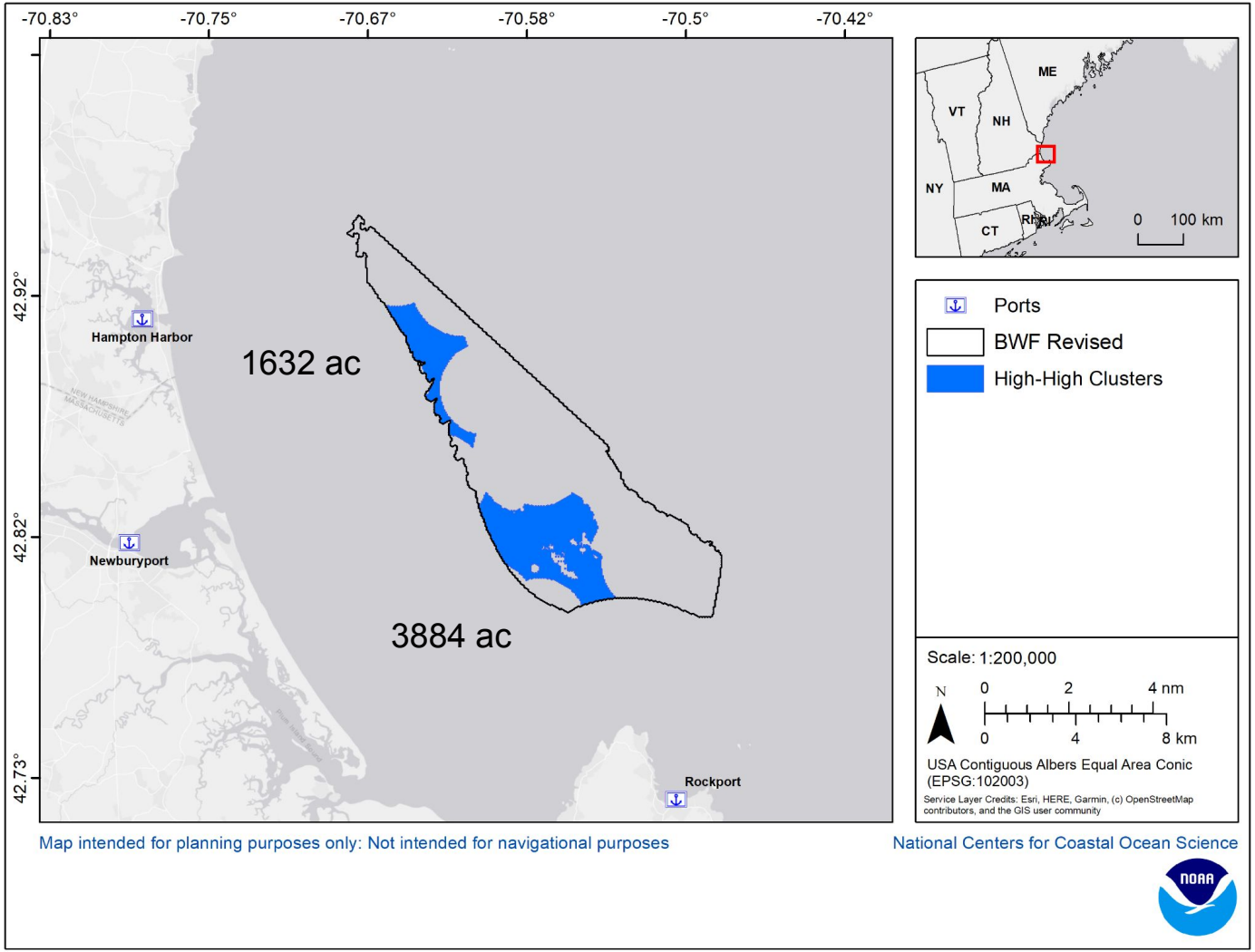
Final Suitability



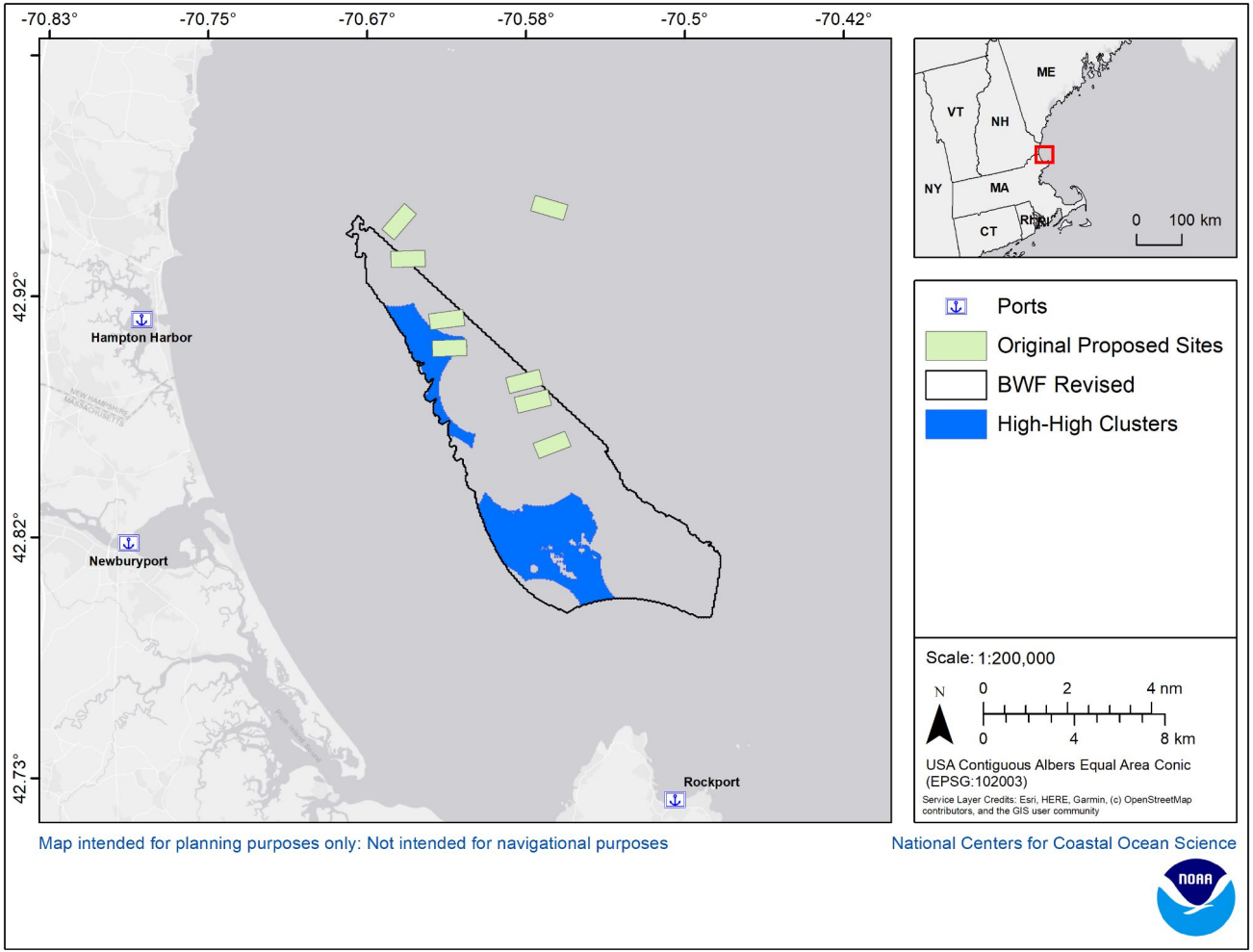
Cluster Analysis

584 m search distance used (265 ac farm)

$p < 0.05$ (CI 95%)



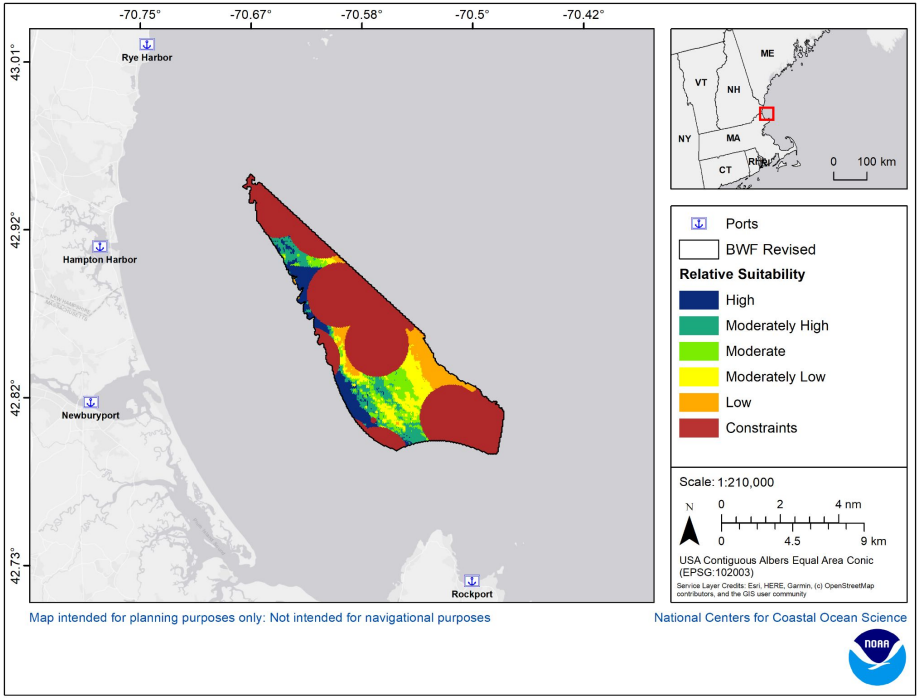
Comparison to Old Analysis



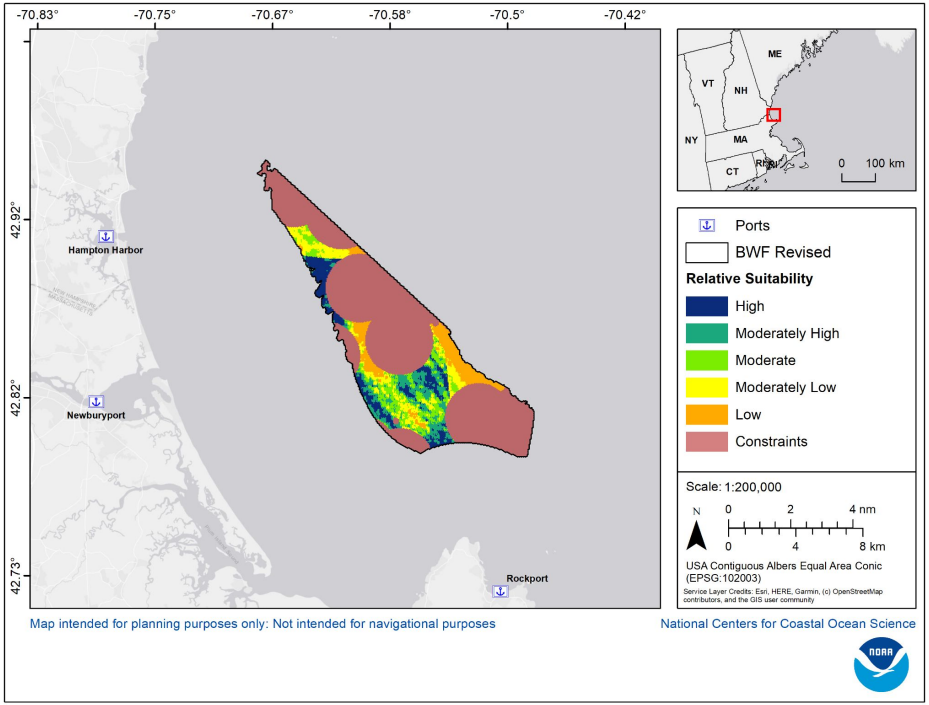
Next Steps

- Review Model and make any adjustments to parameters
- Identify and rank potential farm sites
- Characterize and review potential farm sites

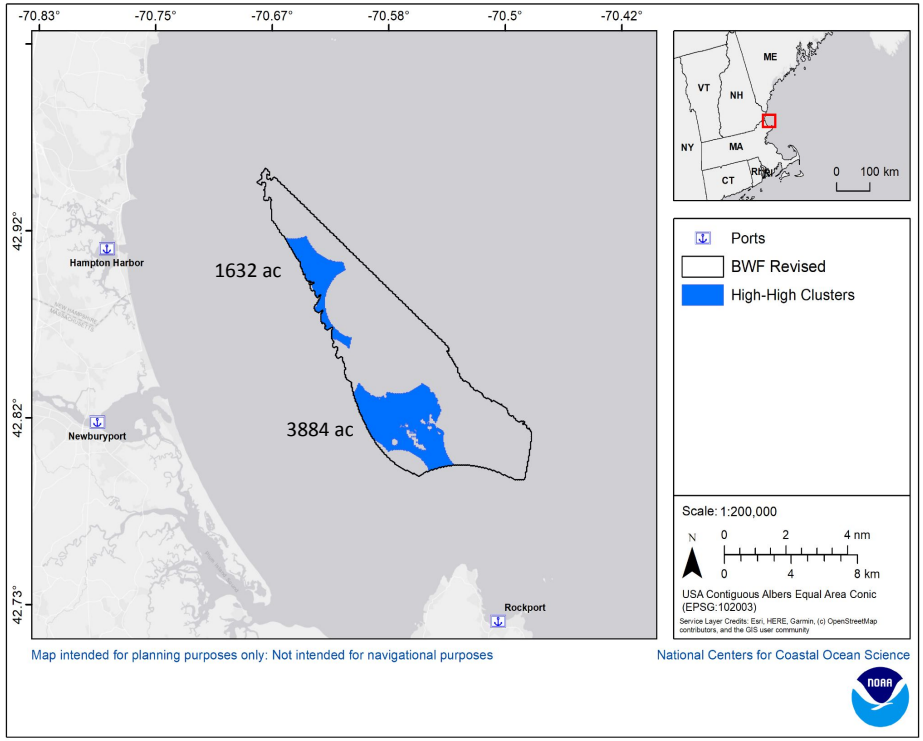
Original Model with Logistics Submodel



New Model without Logistics Submodel



Original Model <u>with</u> Logistics Submodel



Map intended for planning purposes only: Not intended for navigational purposes

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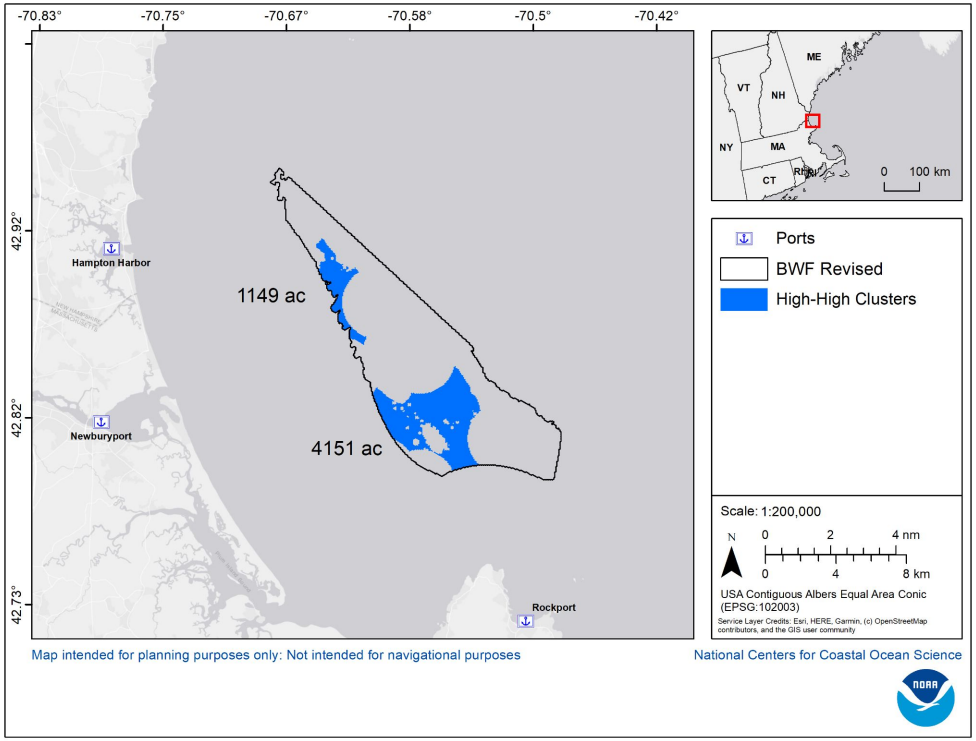
New Model <u>without</u> Logistics Submodel



Map intended for planning purposes only: Not intended for navigational purposes

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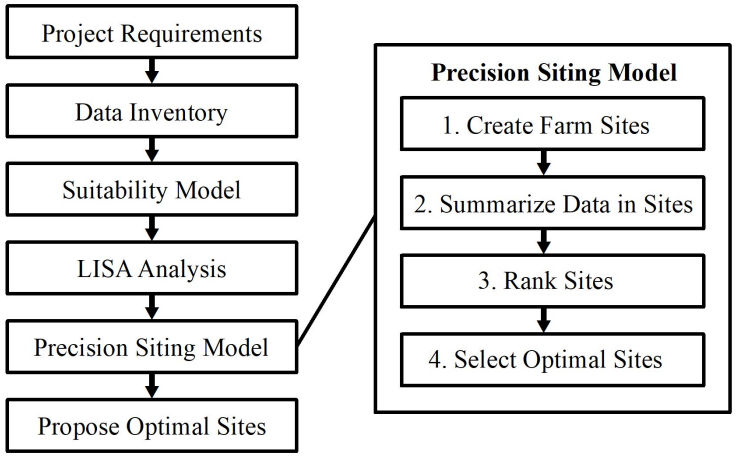
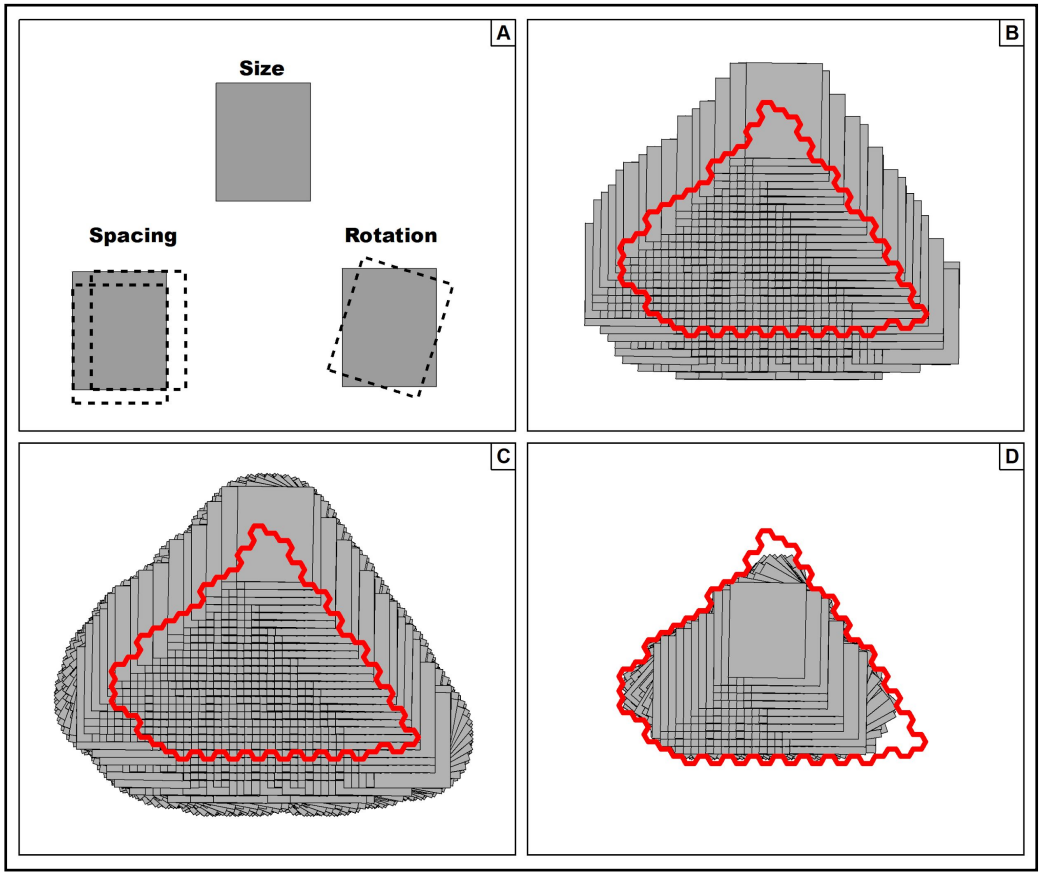
Precision Siting Overview





TOPSIS Analysis

Data Layer	Score
Option perpendicular to current	Linear
AIS SUM 2017-2021	zmf
VMS SUM 2009-2019	zmf

Identify the top three ranked sites that do not overlap

TOPSIS Calculations

$$S_i^+ = \sqrt{\sum_{j=1}^{n} (v_{ij} - v_j^+)^2}$$

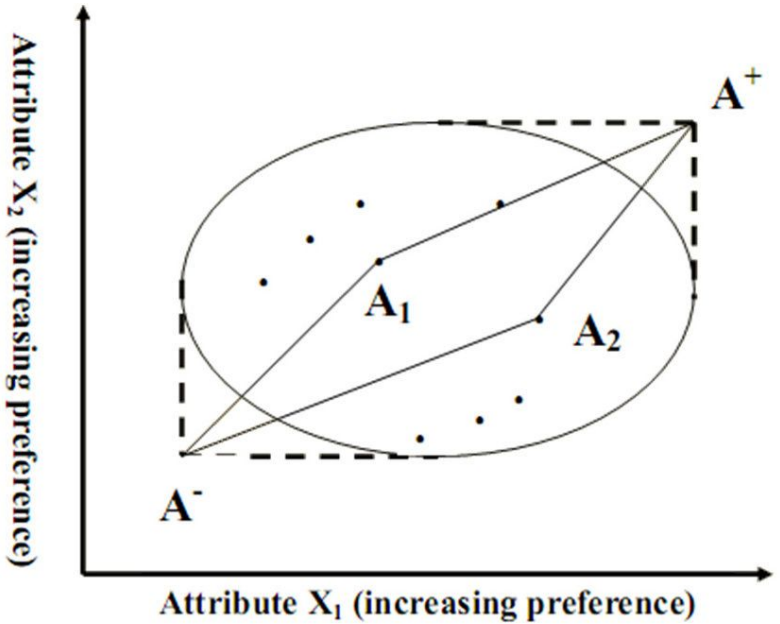
Calculates distance from each alternative site to the most positive solution

$$S_i^- = \sqrt{\sum_{j=1}^{n} (v_{ij} - v_j^-)^2}$$

Calculates distance from each alternative site to the most negative solution

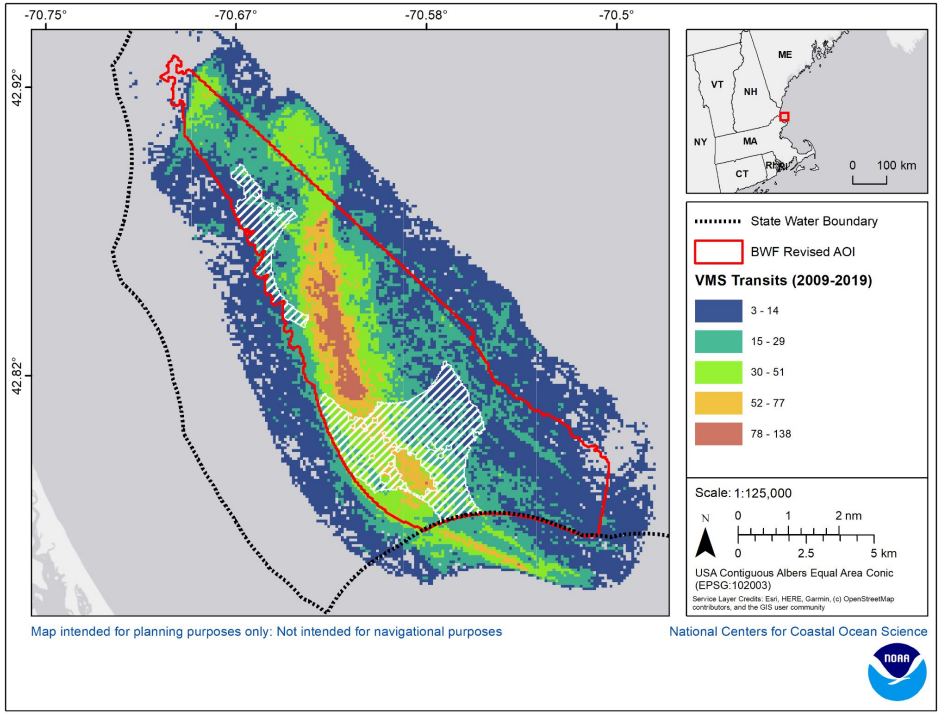
$$\text{TOPSIS Score} = \frac{S_i^-}{(S_i^- + S_i^+)}$$

Calculates the TOPSIS score from each alternative site



S_i^- =Negative Solution
S_i^+ = Positive Solution
v_{ij} = Variable i of j
v_i^+ = Most Positive Score for Variable i
v_i^- = Most Negative Score for Variable i

VMS Transits



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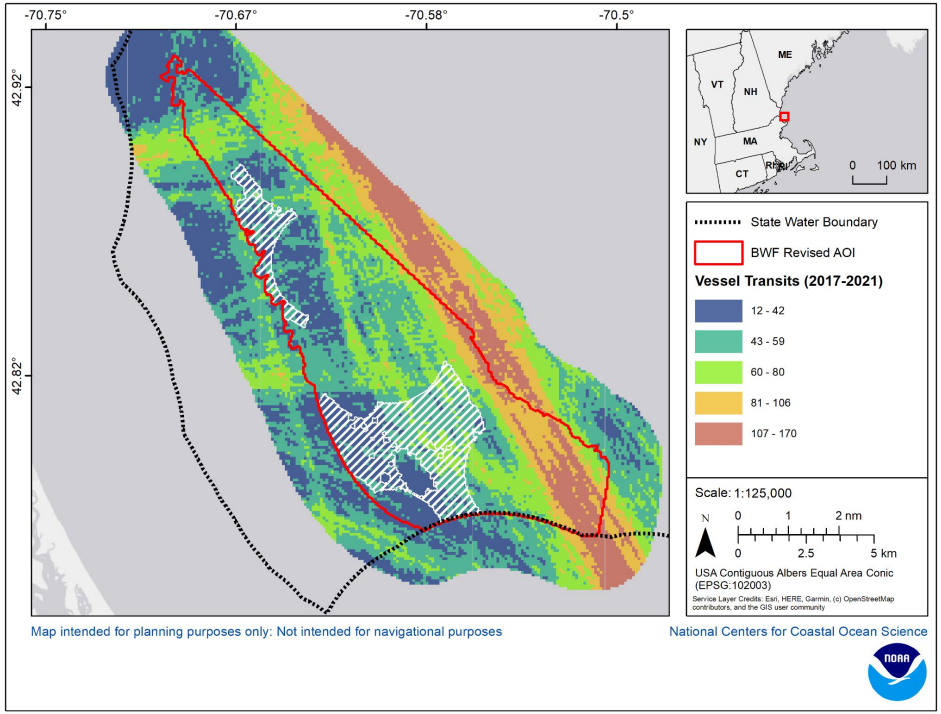
National Centers for Coastal Ocean Science

AIS Transits



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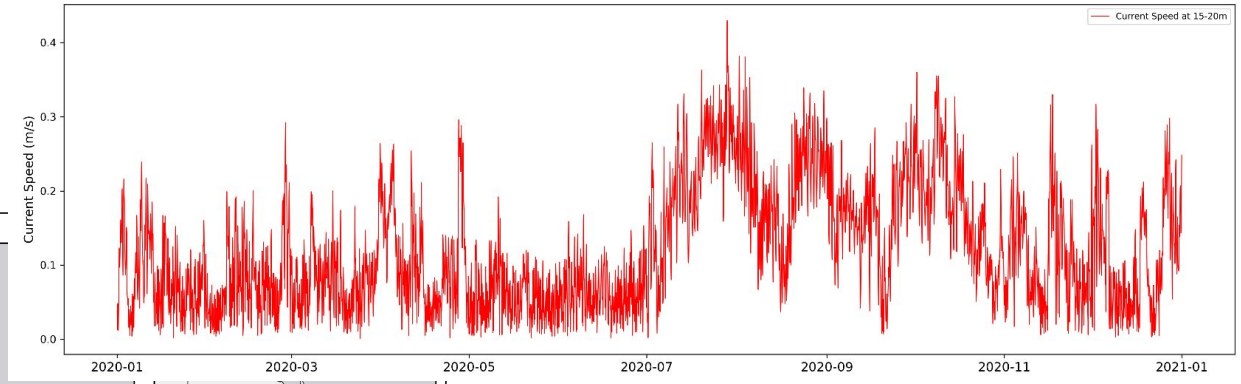
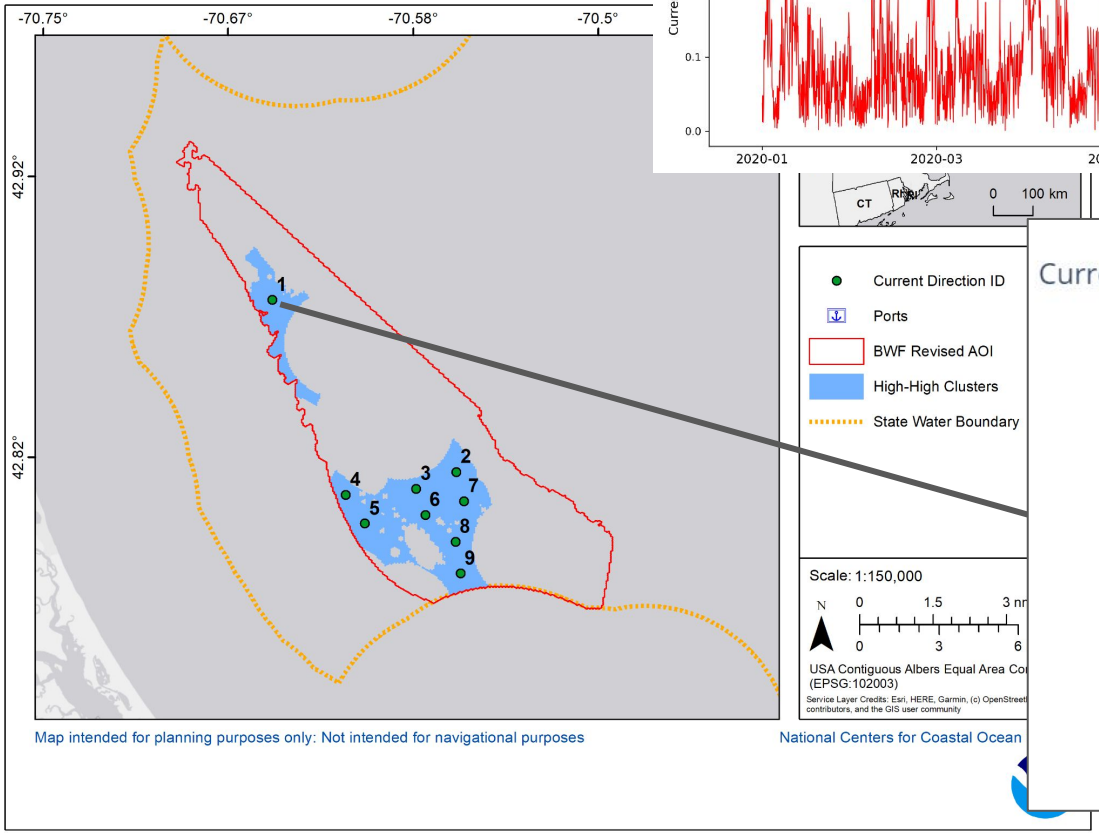
National Centers for Coastal Ocean Science


Current Speed at 15-20m
Current Speed (m/s)
0.0
0.1
0.2
0.3
0.4
2020-01
2020-03
2020-05
2020-07
2020-09
2020-11
2021-01


-70.75°
-70.67°
-70.58°
-70.5°
42.92°
42.82°
1
2
3
4
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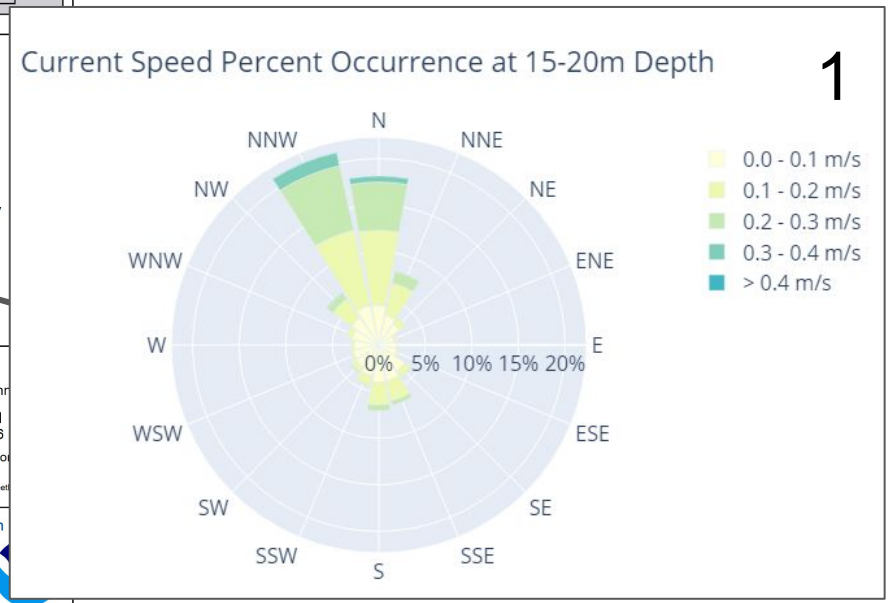
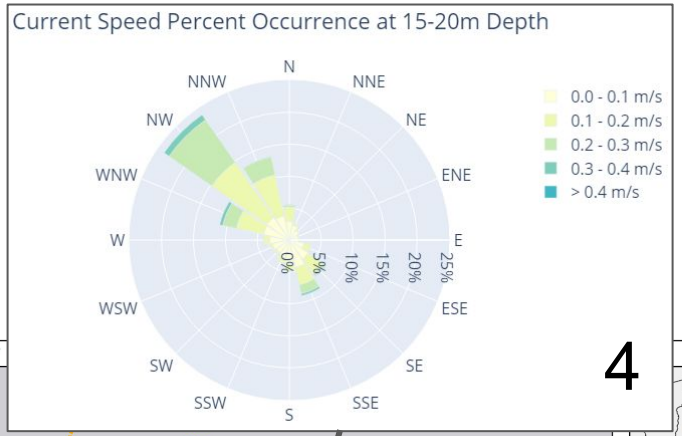
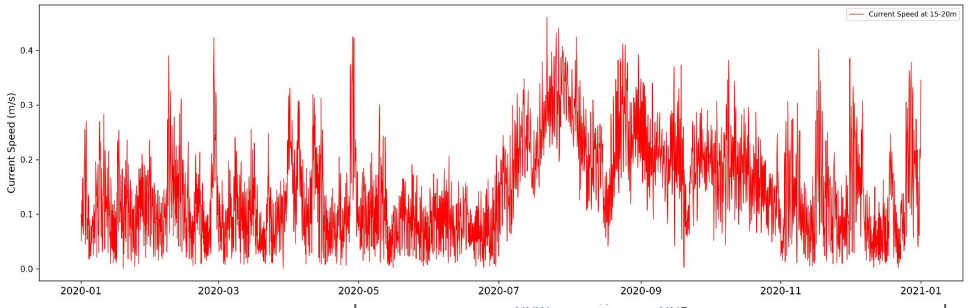
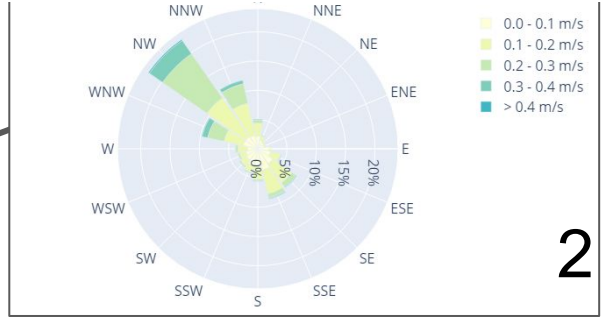
7
8
9
CT
RI
0
100 km
Current Direction ID
Ports
BWF Revised AOI
High-High Clusters
State Water Boundary
Scale: 1:150,000
N
0
1.5
3 nm
0
3
6
USA Contiguous Albers Equal Area Co
(EPSG:102003)
Service Layer Credits: Esri, HERE, Garmin, (c) OpenStreet
contributors, and the GIS user community
Map intended for planning purposes only: Not intended for navigational purposes
National Centers for Coastal Ocean


Current Speed Percent Occurrence at 15-20m Depth
1
N
NNE
NE
ENE
E
ESE
SE
SSE
S
SSW
SW
WSW
W
WNW
NW
NNW
0%
5%
10%
15%
20%
0.0 - 0.1 m/s
0.1 - 0.2 m/s
0.2 - 0.3 m/s
0.3 - 0.4 m/s
> 0.4 m/s


Current Speed Percent Occurrence at 15-20m Depth
N
NNE
NE
ENE
E
ESE
SE
SSE
S
SSW
SW
WSW
W
WNW
NW
NNW
0%
5%
10%
15%
20%
25%
0.0 - 0.1 m/s
0.1 - 0.2 m/s
0.2 - 0.3 m/s
0.3 - 0.4 m/s
> 0.4 m/s
4


Current Speed at 15-20m
Current Speed (m/s)
0.0
0.1
0.2
0.3
0.4
2020-01
2020-03
2020-05
2020-07
2020-09
2020-11
2021-01


N
NNE
NE
ENE
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ESE
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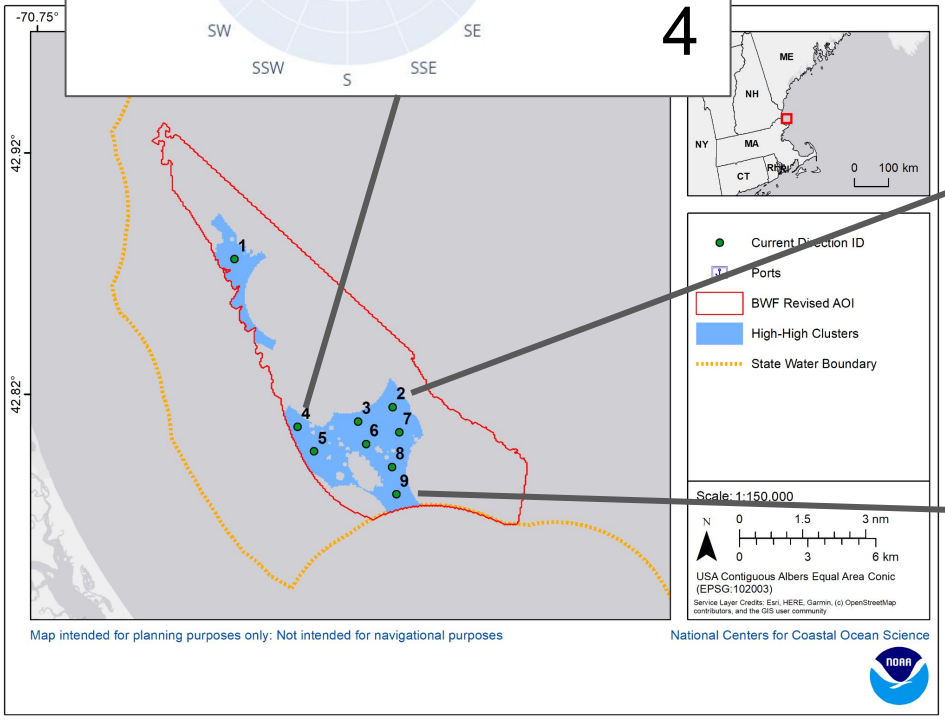
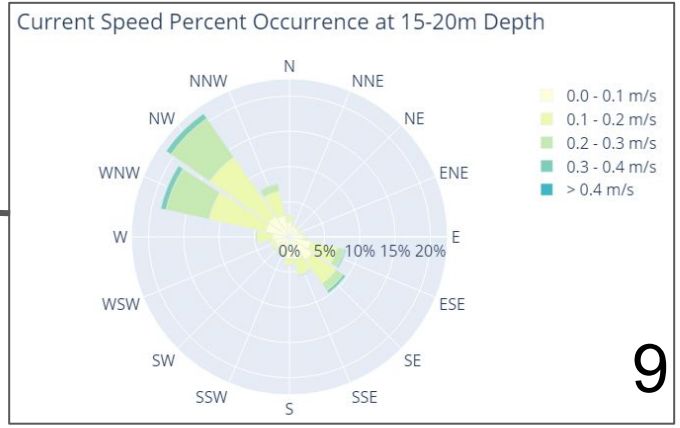
SSE
S
SSW
SW
WSW
W
WNW
NW
NNW
0%
5%
10%
15%
20%
0.0 - 0.1 m/s
0.1 - 0.2 m/s
0.2 - 0.3 m/s
0.3 - 0.4 m/s
> 0.4 m/s
2


-70.75°
42.92°
42.82°
1
2
3
4
5
6
7
8
9
ME
NH
NY
MA
CT
RI
0
100 km
Current Direction ID
Ports
BWF Revised AOI
High-High Clusters
State Water Boundary
Scale: 1:150,000
N
0
1.5
3 nm
0
3
6 km
USA Contiguous Albers Equal Area Conic
(EPSG:102003)
Service Layer Credits: Esri, HERE, Garmin, (c) OpenStreetMap contributors, and the GIS user community
Map intended for planning purposes only: Not intended for navigational purposes
National Centers for Coastal Ocean Science
NOAA


Current Speed Percent Occurrence at 15-20m Depth
N
NNE
NE
ENE
E
ESE
SE
SSE
S
SSW
SW
WSW
W
WNW
NW
NNW
0%
5%
10%
15%
20%
0.0 - 0.1 m/s
0.1 - 0.2 m/s
0.2 - 0.3 m/s
0.3 - 0.4 m/s
> 0.4 m/s
9

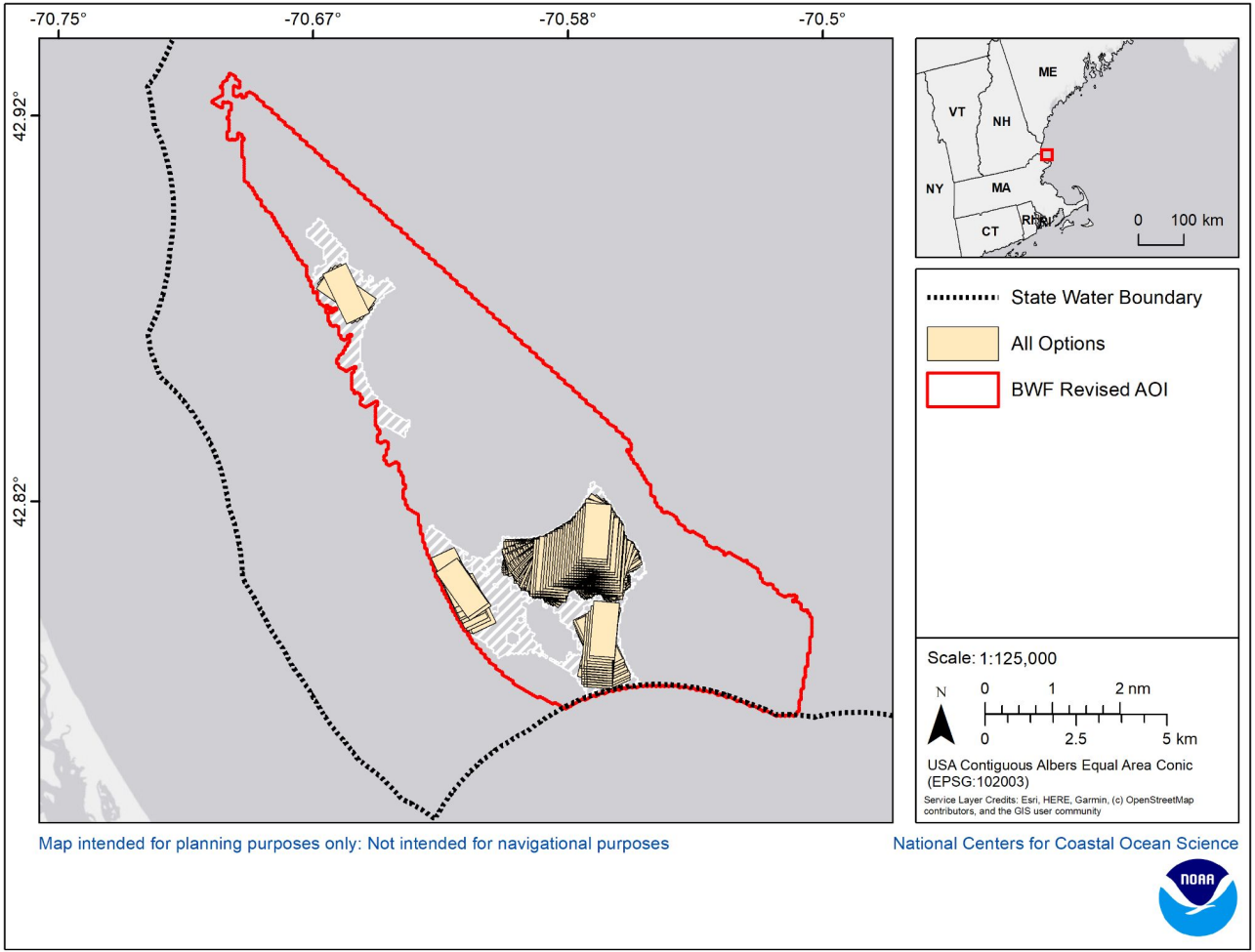
Potential Options

3850 options evaluated

All options are 265 ac (1508 m x 711 m)

All options rotated by 10°

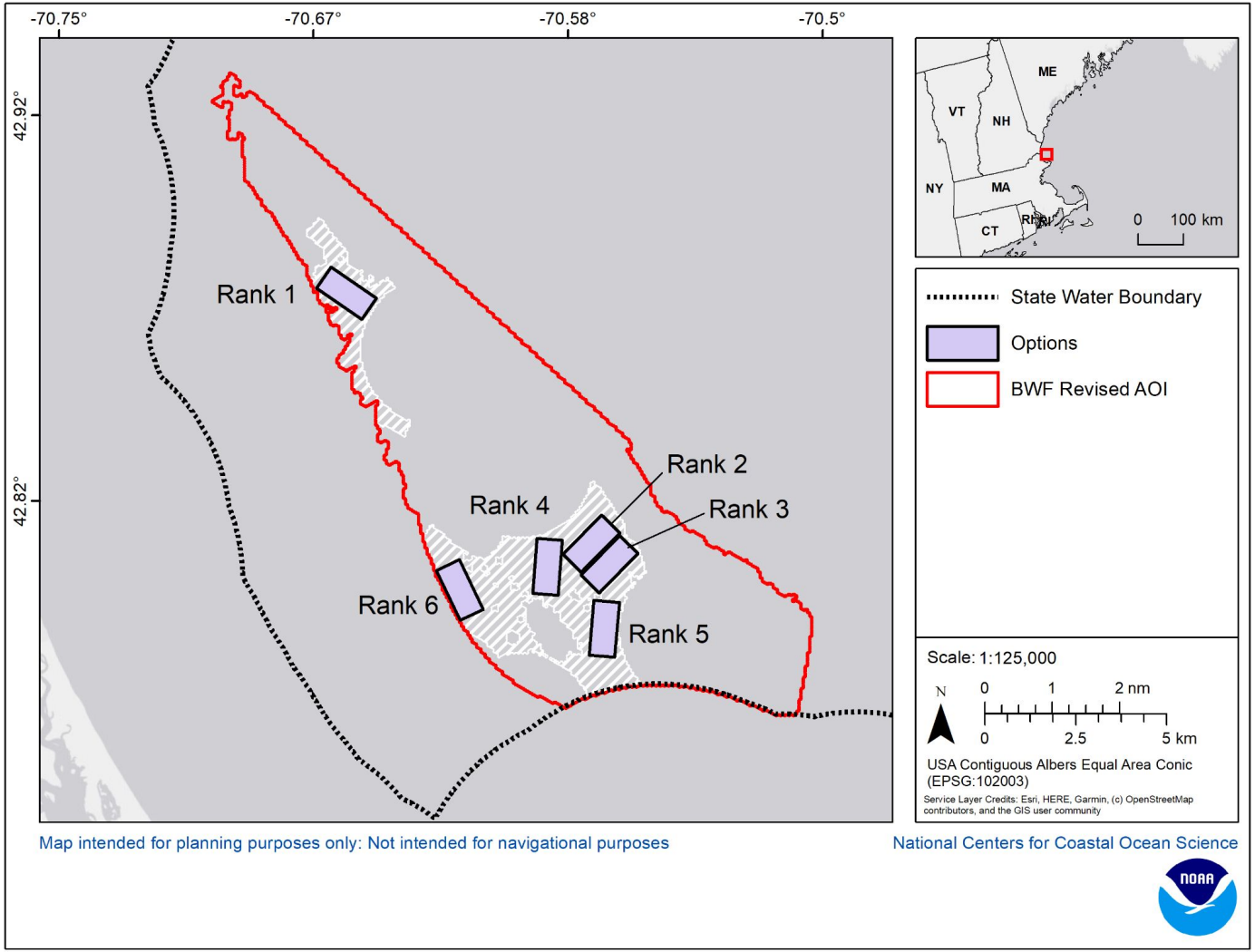
All options spaced by 71m (1/10 of width)



Ranked Options

Top Ranking options with no overlap with other options

Total of 6 identified, top three chosen for further review



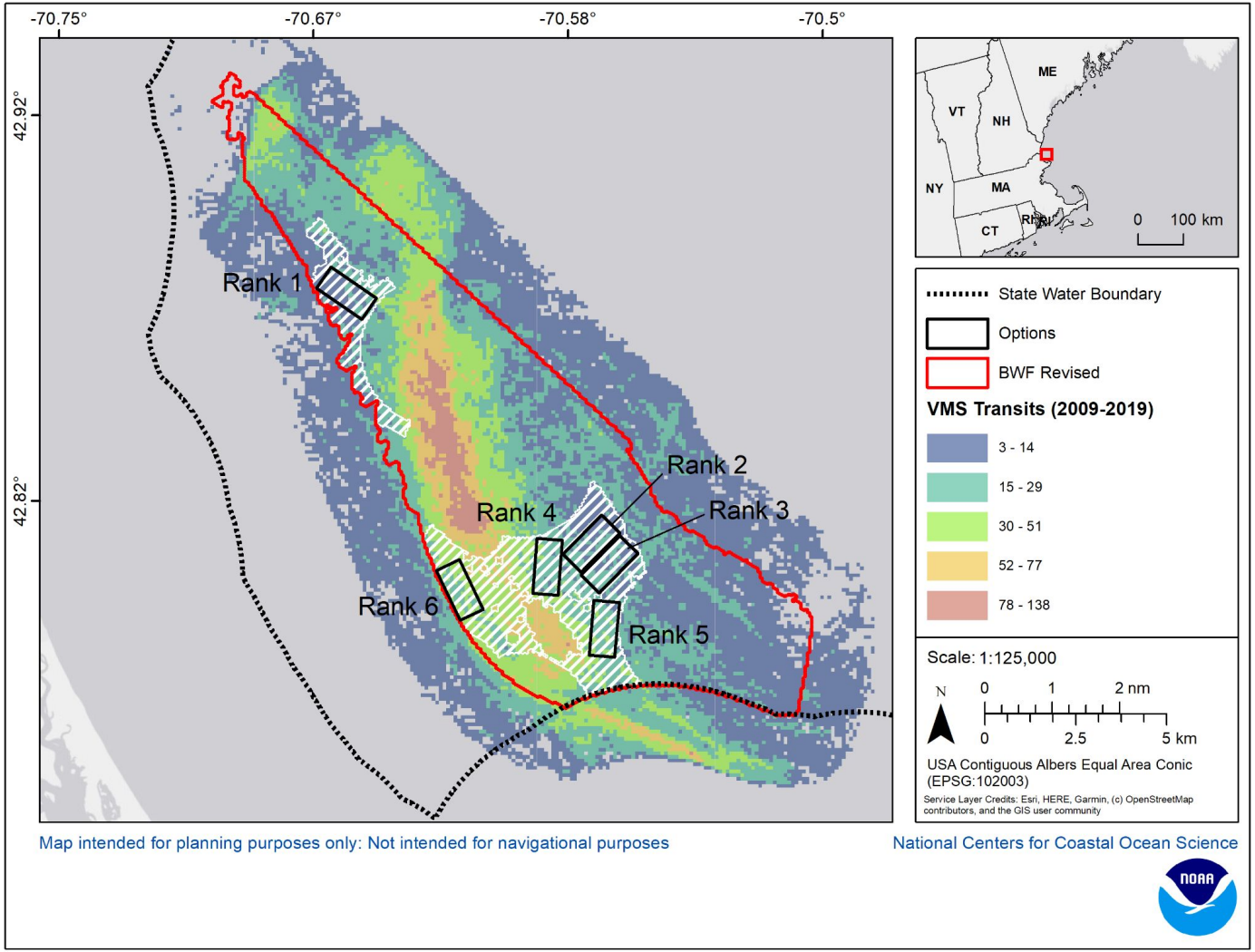
TOPSIS Option Ranking

Rank	Option	AIS/265ac	VMS/265ac	Degrees from Ideal	TOPSIS Score
1	1-1	55	1871	79.5	0.64
2	2-1	66	1966	0.5	0.63
3	2-2	75	2124	0.5	0.58
4	2-3	67	3078	40.5	0.45
5	2-4	69	3138	40.1	0.42
6	2-5	47	4364	109.5	0.42

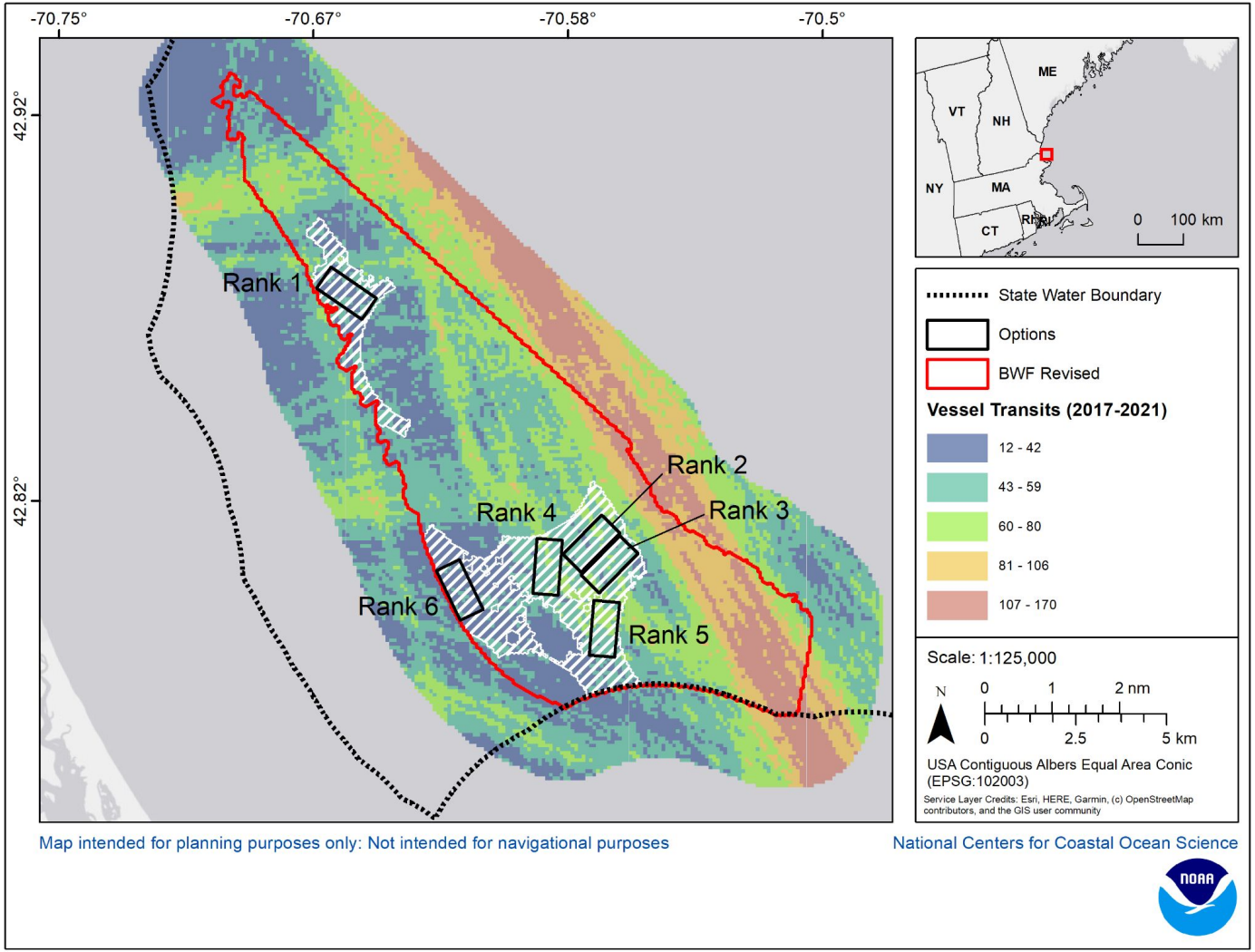
Ranks for Options

Option	AIS Rank	VMS Rank	Degrees from ideal Rank	TOPSIS Score	Rank
1-1	2	1	5	0.64	1
2-1	3	2	1	0.63	2
2-2	6	3	2	0.58	3
2-3	4	4	4	0.45	4
2-4	5	5	3	0.42	5
2-5	1	6	6	0.42	6

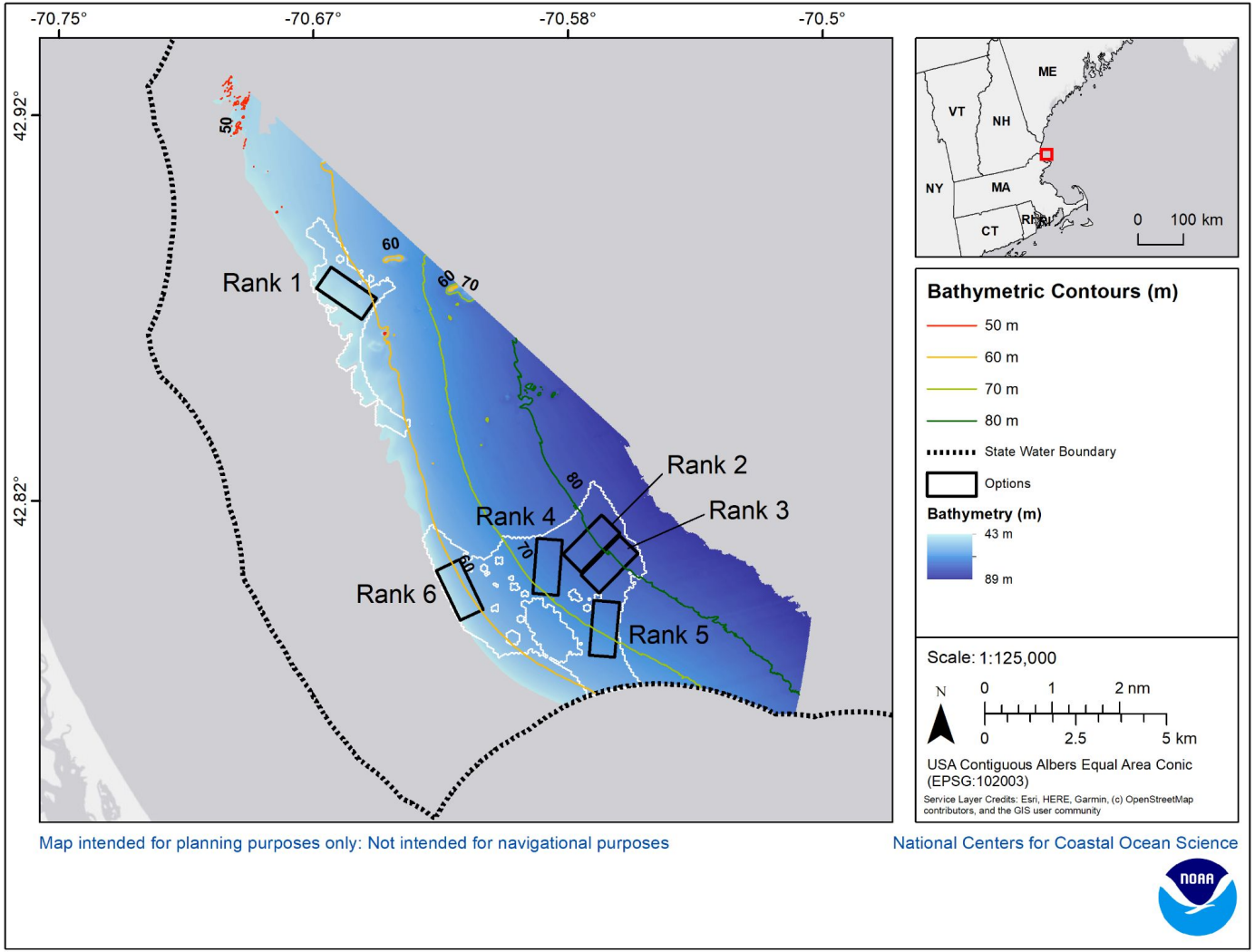
VMS


-70.75°
-70.67°
-70.58°
-70.5°
42.92°
42.82°
Rank 1
Rank 2
Rank 3
Rank 4
Rank 5
Rank 6
ME
VT
NH
NY
MA
CT
RI
0
100 km
State Water Boundary
Options
BWF Revised
VMS Transits (2009-2019)
3 - 14
15 - 29
30 - 51
52 - 77
78 - 138
Scale: 1:125,000
N
0
1
2 nm
0
2.5
5 km
USA Contiguous Albers Equal Area Conic (EPSG:102003)
Service Layer Credits: Esri, HERE, Garmin, (c) OpenStreetMap contributors, and the GIS user community
Map intended for planning purposes only: Not intended for navigational purposes
National Centers for Coastal Ocean Science
NOAA

AIS


-70.75°
-70.67°
-70.58°
-70.5°
42.92°
42.82°
Rank 1
Rank 2
Rank 3
Rank 4
Rank 5
Rank 6
ME
VT
NH
NY
MA
CT
RI
0
100 km
State Water Boundary
Options
BWF Revised
Vessel Transits (2017-2021)
12 - 42
43 - 59
60 - 80
81 - 106
107 - 170
Scale: 1:125,000
N
0
1
2 nm
0
2.5
5 km
USA Contiguous Albers Equal Area Conic (EPSG:102003)
Service Layer Credits: Esri, HERE, Garmin, (c) OpenStreetMap contributors, and the GIS user community
Map intended for planning purposes only: Not intended for navigational purposes
National Centers for Coastal Ocean Science
NOAA

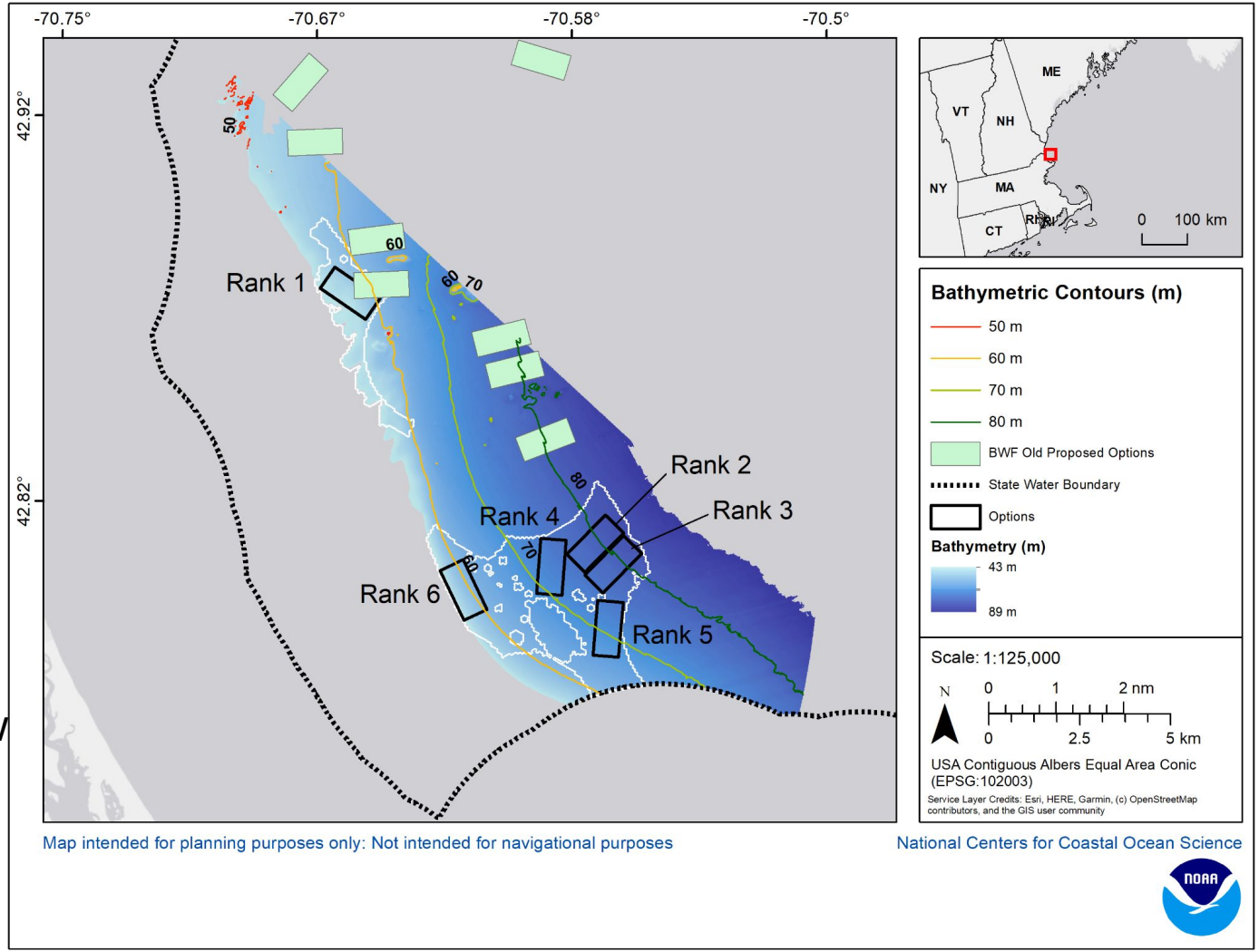
Bathymetry


-70.75°
-70.67°
-70.58°
-70.5°
42.92°
42.82°
50
60
70
80
Rank 1
Rank 2
Rank 3
Rank 4
Rank 5
Rank 6
ME
VT
NH
NY
MA
CT
RI
0
100 km
Bathymetric Contours (m)
50 m
60 m
70 m
80 m
State Water Boundary
Options
Bathymetry (m)
43 m
89 m
Scale: 1:125,000
N
0
1
2 nm
0
2.5
5 km
USA Contiguous Albers Equal Area Conic (EPSG:102003)
Service Layer Credits: Esri, HERE, Garmin, (c) OpenStreetMap contributors, and the GIS user community
Map intended for planning purposes only: Not intended for navigational purposes
National Centers for Coastal Ocean Science
NOAA

Comparison to Original analysis

None of the newly proposed options are near any location where Cod spawning has been recorded*

*Does not mean cod spawning could not occur in any of the new options



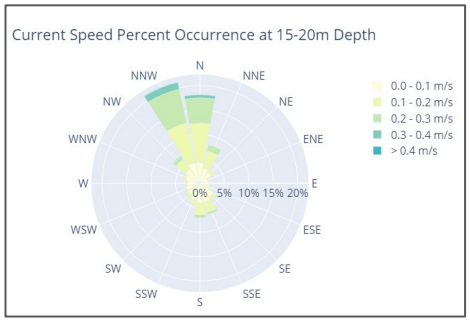
Site 1-1

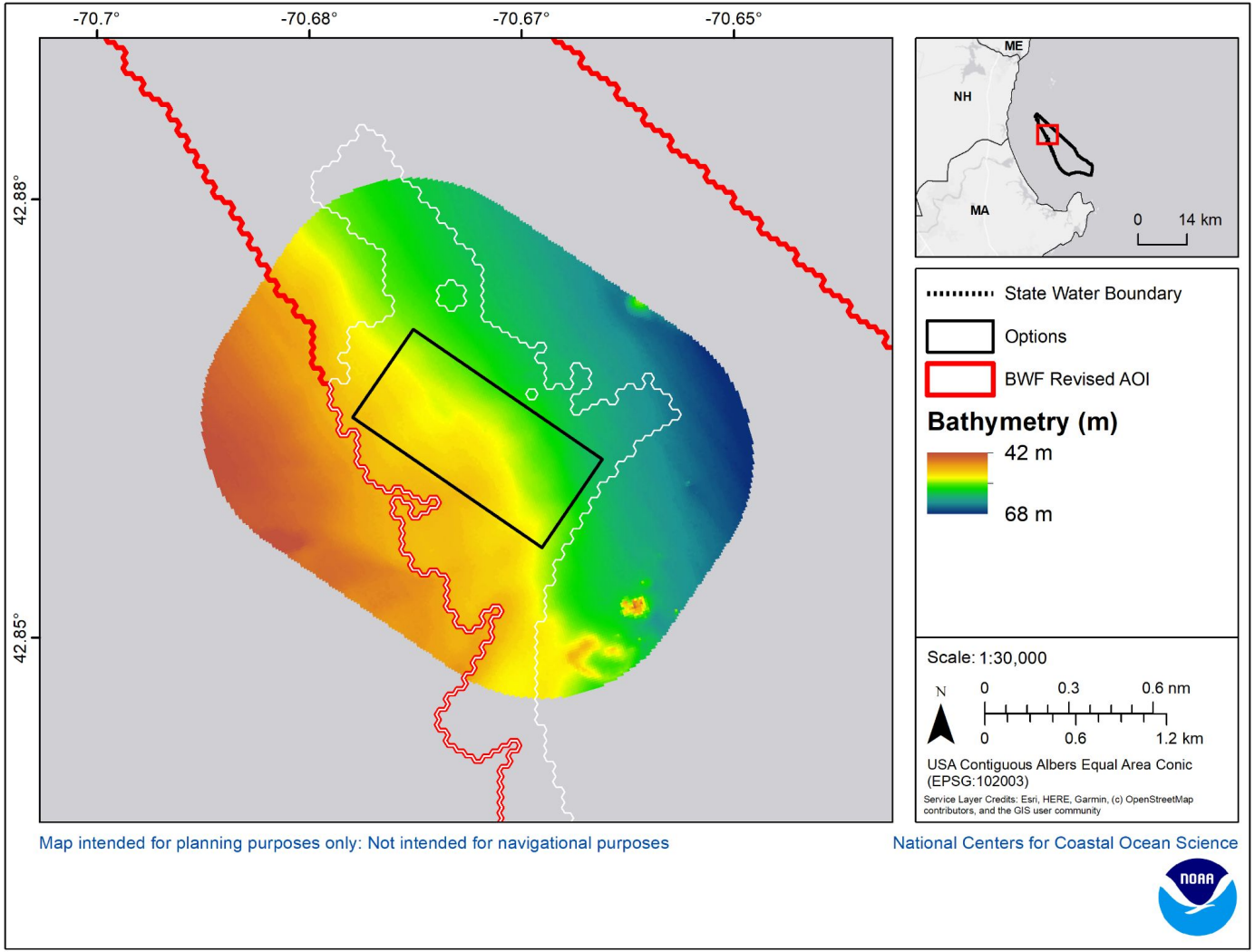
Only site in North Cluster

Near potential Hardbottom

Shallowest of sites

Lower vessel fishing effort than most other sites

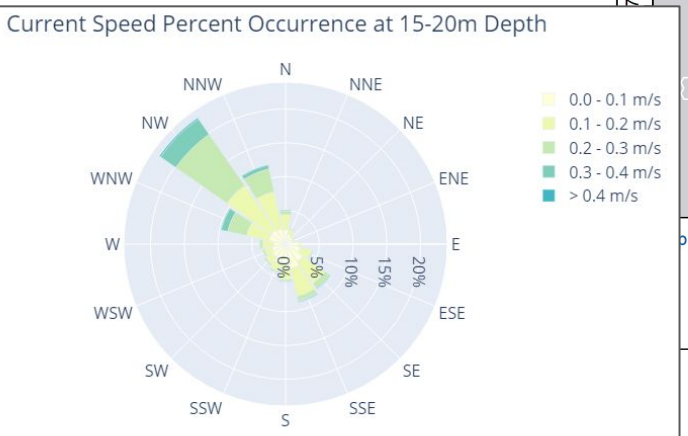


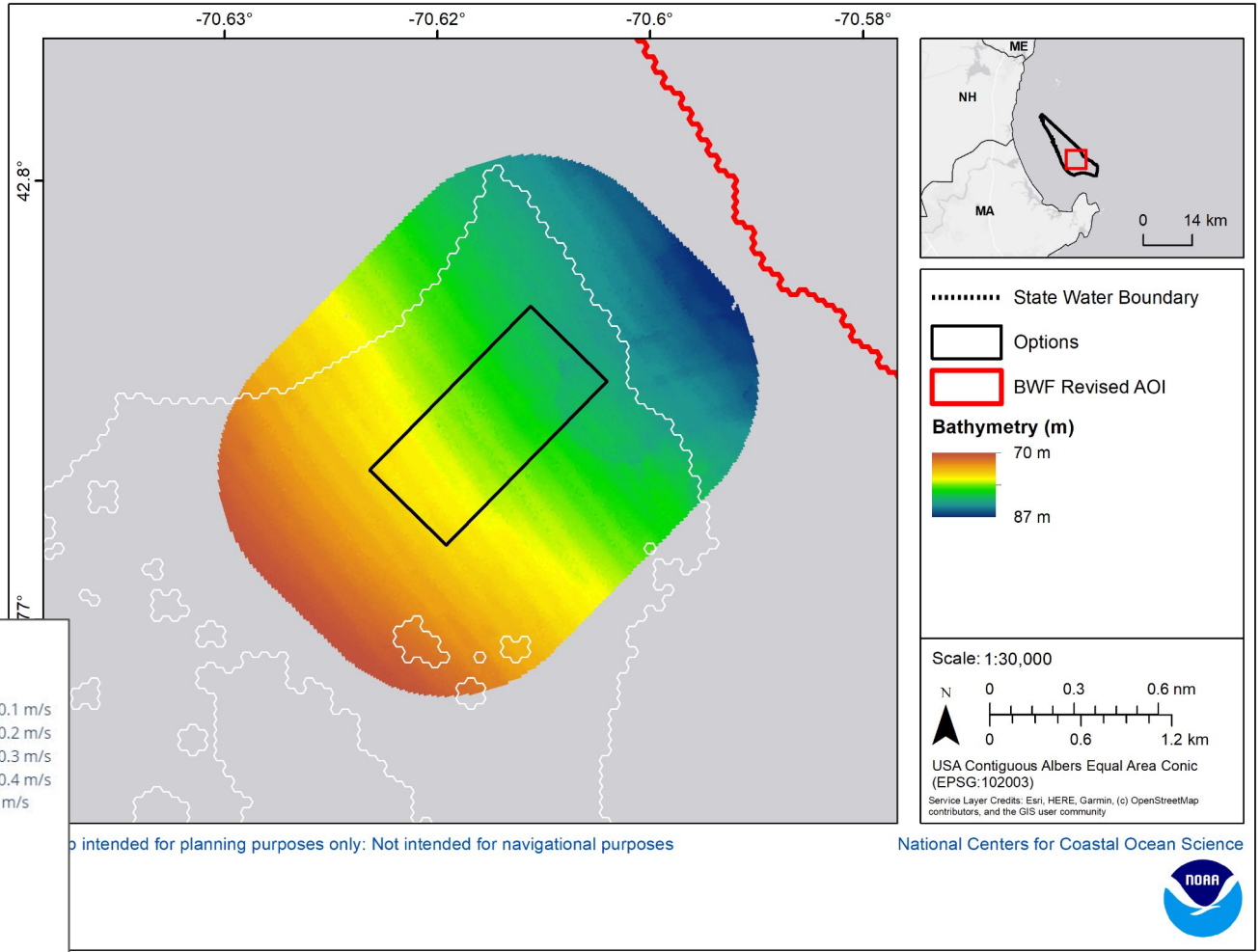


Site 2-1

Ideal site between high vessel traffic and high fishing transits

Deeper site, perpendicular to current

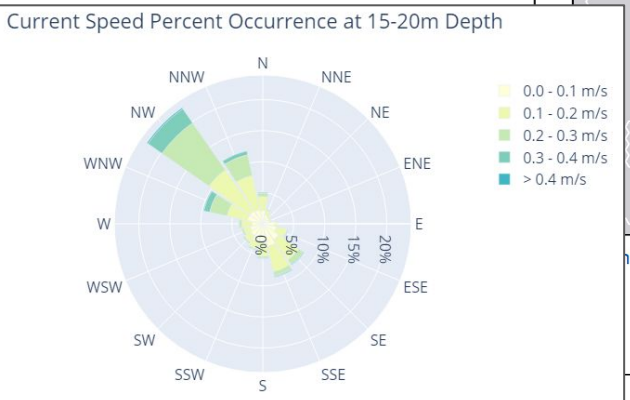


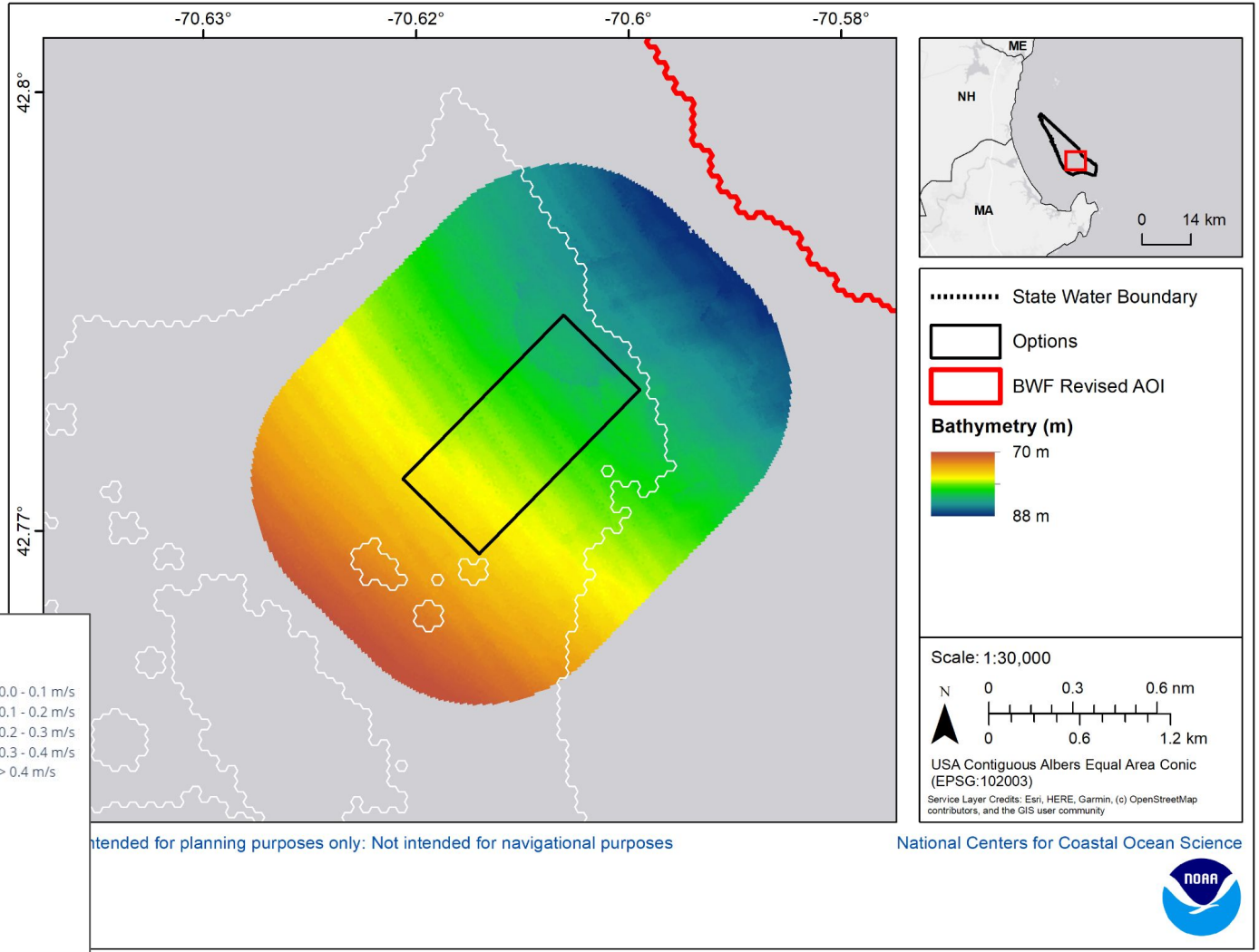


Site 2-2

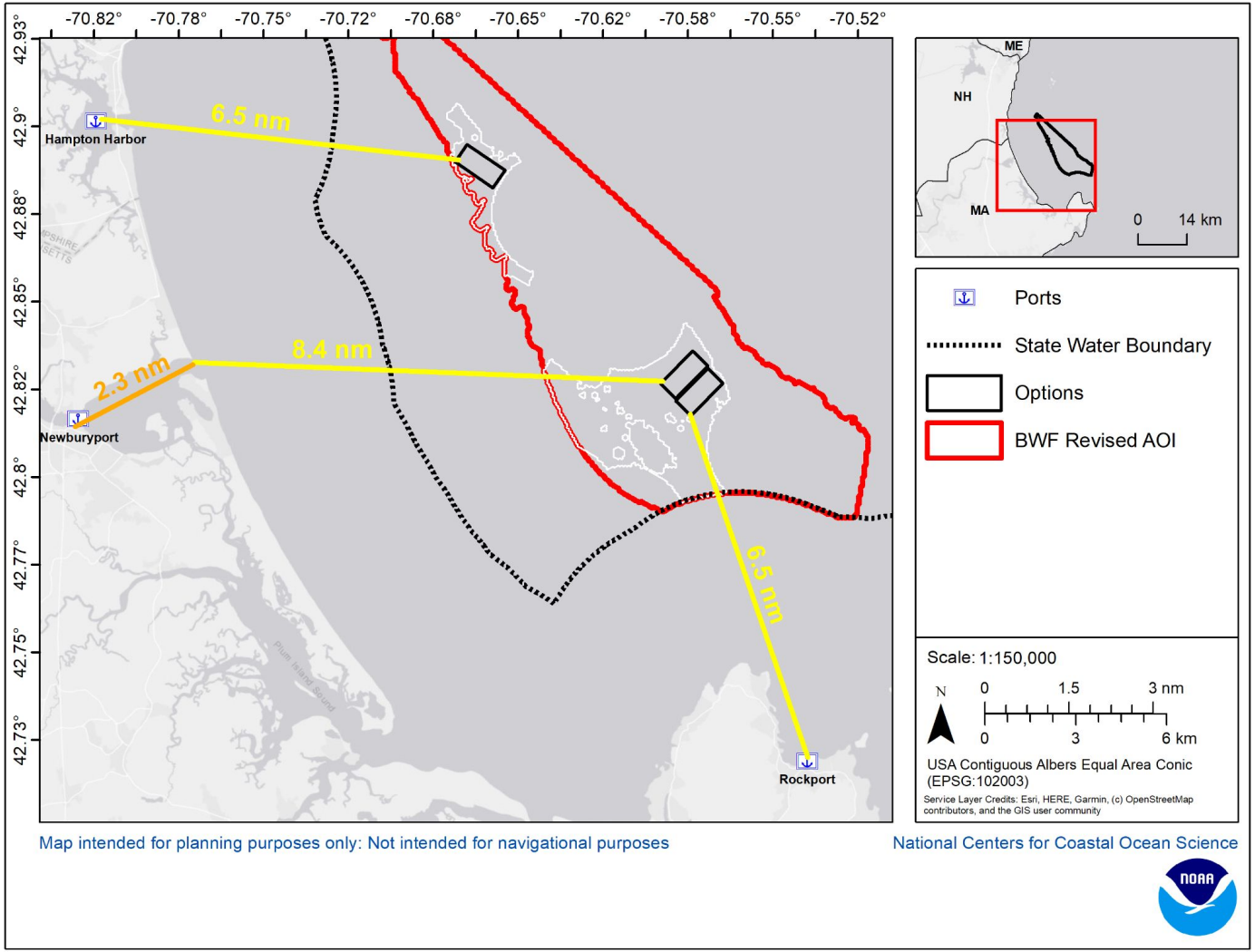
Ideal site between high vessel traffic and high fishing transits

Deeper site, perpendicular to current





Distance to ports



Spacing of 2-1 and 2-2

Adjustment of spacing between sites could be performed if needed